National Aeronautics and Space Administration

HIGH-END COMPUTING CAPABILITY PORTFOLIO

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NASA Advanced Supercomputing Division

June 10, 2022

HECC Teams Complete Annual Facilities Maintenance

- HECC facilities engineers teamed with NASA Ames Code J/Jacobs staff to plan, coordinate, and conduct the annual N258, R&D088, and R&D099 building maintenance, which included numerous repairs and upkeep of key components of the facilities.
- The three facilities required complete power shutdowns to facilitate the numerous tasks. Pleiades, Electra, Aitken, and storage equipment were powered off with all the support infrastructure.
- The following were some of the key activities completed:
  - Cleaned the cooling tower fans, fill, and basin. Cleaned condenser tubes of the N258 chillers. Replaced belts and filters on the building and computer room air handlers.
  - Cleaned and tested 14kV and 480V power switchgear and circuit breakers.
  - Cleaned the N258 computer room sub-floor plenum and floor tiles.
  - Tested new VESDA smoke detection system and its integration into the N258 Utility Control System.
  - Cleaned the R&D088 roof top adiabatic coolers.
  - Replaced five overheated R&D088 pin and sleeve connectors.
  - Cleaned and tightened panelboard electrical connections that feed Pleiades, Electra, and Aitken.

IMPACT: Preventative maintenance to the supercomputing facilities' cooling systems and electrical distribution reduces downtime caused by an aging infrastructure, yielding more compute uptime for HECC users.

A technician cleans the fan blades on top of the N258 cooling tower with a high-pressure water hose. *Chris Tanner, NASA/Ames*

User Data Successfully Migrated to New RAID Hardware

- The Supercomputing Systems team completed the migration of HECC users' non-transient, archived data from older RAID equipment, which had reached the end of its support life, to new RAID hardware.
  - User data is stored in home filesystems that are made available via the Network File System (NFS), allowing users access to their data across the entire HECC computing environment.
  - The migration of home filesystems to the newer hardware was done transparently while the filesystems were in production, with no impact to users.
- This work supports an ongoing efforts to decommission obsolete equipment within the HECC environment and modernize infrastructure.
  - The disks in the new RAID equipment are four times larger than the disks in the old RAID equipment (300 gigabytes per disk vs 1.2 terabytes per disk).
  - The new hardware is configured using the NetApp E-Series E2800 storage system, with a Secure-Erase capability, which could remove the need to destroy bad disks saving time and money.
  - The E2800 system also supports Transport Layer Security (TLS) Protocol Version 1.3 (TLS 1.3), compared to TLS 1.2, which was used on the old RAID hardware.

IMPACT: HECC home filesystems contain critical user data for NAS projects. Migrating them to faster, currently supported storage hardware will improve the user experience within the NAS computing environment.

The new RAID storage equipment installed at the NASA Advanced Supercomputing facility has the capacity to store four times the amount of scientific data than the previous RAID hardware.
Don Story, NASA/Ames

HECC Delivers Annual Report for Fiscal Year 2021

- Three HECC teams collaborated to develop and deliver the project's Annual Report (AR) for Fiscal Year 2021, which outlines facility enhancements achieved during the year, summarizes 780 unique science and engineering projects enabled by HECC resources, and highlights 40 selected projects.
- The User Services, Tools, and Pubs-Media teams created the report, starting with collecting information from hundreds of principal investigators (PIs) who lead projects that depend on HECC resources.
  - The Tools team added a module to myNAS that enables PIs to easily submit their individual FY21 report content for use in the report (see slide 7).
  - PIs provided summaries of how they used HECC resources in FY21, the impact and results of their work, milestones achieved, and publications produced.
  - The User Services and Pubs-Media teams worked with the 40 PIs over several months to develop the project highlights showcasing their achievements.
- Among the highlighted science and engineering projects are:
  - ARMD: Modeling sonic boom noise; simulating X-57 electric and multi-rotor urban air mobility concepts; and design optimization for fuel-efficient aircraft.
  - HEOMD/STMD/NESC: Simulating the KSC launch pad to support Artemis; analyzing the Mars Sample Return vehicle; and supporting development of human landing systems.
  - SMD: Modeling the atmosphere of Mars and exoplanets; discovering the effects of air pollution on precipitation; and simulating galaxy evolution.

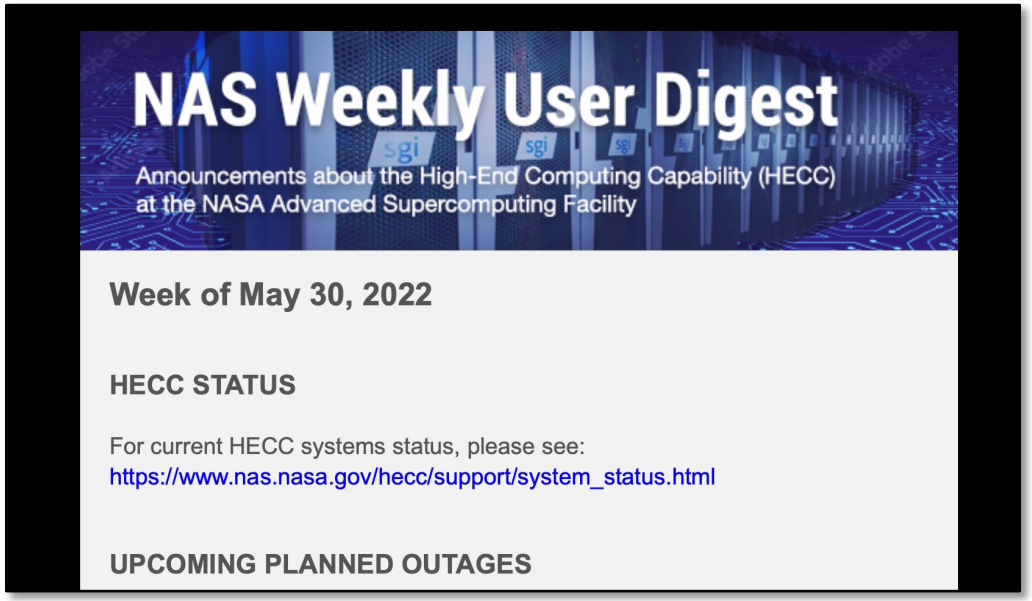
IMPACT: The HECC Annual Report is key to providing Return-on-Investment (ROI) to NASA mission directorates and spotlights the scientific and engineering value received from the agency's high-performance computing assets.

Snapshot of the FY21 HECC Annual Report cover page. Each fiscal year HECC highlights science and engineering achievements made possible by HECC resources and reports total SBUs allocated to and used by NASA mission directorates. *Marco Librero, NASA/Ames*

HECC Introduces New User Digest and Email Procedures

- As part of Phase II of the User Communication project, the first ever weekly HECC User Digest went out on Tuesday, May 31.
  - The goal is to reduce the number of emails users receive, while consolidating information in a consistent, easy-to-read, and reliable format.
- A new Remedy module developed by HECC's Tools team allows the digest production team to automate distribution of the digest and reminder emails for scheduled events.
  - This capability ensures that users get the right information delivered at the right time.
  - The Tools team also designed the digest look and format to be viewed consistently in most email platforms.
- New templates and procedures developed by the User Services and Publications & Media team streamline and formalize processes for sending email to the broader user community.
  - Procedures cover both scheduled and urgent event types.
  - Templates cover a broad range of scenarios to ensure all relevant details are incorporated and provide consistent wording and tone.
- The process is designed to improve oversight and general awareness of the information HECC communicates to users.

IMPACT: The new user email digest makes it easier for users to stay informed on HECC-related events that affect their computational jobs, training opportunities, and more. New procedures and email templates enable streamlined processes for technical teams that need to send notifications to users.

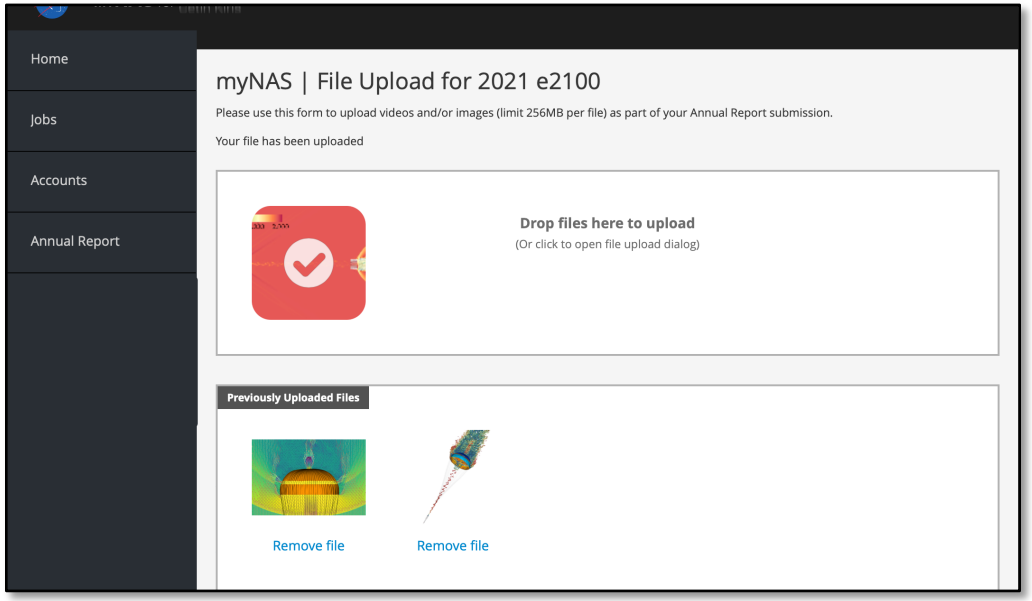


Screenshot from the first weekly email digest, which was distributed to the user community on May 31. Users will receive a new digest every Tuesday morning. *Emily Kuhse, NASA/Ames*

New myNAS Module Streamlines Annual Report Process

- The HECC Tools team designed, developed, and successfully deployed a new myNAS module to gather and organize data from hundreds of GIDs for the HECC Annual Report (AR; see slide 5).
  - The Tools team worked closely with the User Services and Pubs Media teams to gather requirements and test new features.
  - While the project leveraged existing myNAS infrastructure, significant new capabilities were developed using Python and Javascript.
- The AR admin area provides a central location where HECC team members can build the survey for a given fiscal year, release it to users, track responses, and trigger email reminders.
- After the survey is released to Principal Investigators (PIs), it is accessible through a menu item in myNAS, where they can edit responses for each GID, upload files, optionally assign a co-author, and submit their report content. Basic information about each GID is automatically pre-filled by the system. PIs may save their responses and return later to edit them until final submission.
- After submission, AR team members can review, filter, and sort the responses in the admin area to speed the down-selection process. Selected responses are downloadable in multiple file formats.

IMPACT: The new myNAS module centralizes the HECC Annual Report process, while improving efficiency and ease-of-use for both HECC team members and users. Making it easier for PIs to respond to the data call increased participation by approximately 20% over the previous year.



Screenshot of the drag-and-drop file upload interface in the myNAS annual report module. It allows principal investigators to attach images and videos to their annual report submissions for each GID. *John Hardman, NASA/Ames*

3D Hydrodynamics Modeling Captures the Effects of Solar Rotation*

- High-resolution observations made by NASA's Solar Dynamics Observatory (SDO) provide a unique opportunity to investigate solar dynamics and analyze variations in differential rotation and meridional circulation due to magnetic activity.
- To improve the understanding of how the Sun operates through realistic modeling and synthetic observations, a team of heliophysicists at NASA Ames used available technology and computational capabilities to test new methods for analyzing SDO observations.
- The team performed simulations on Pleiades of a patch of the solar surface that revealed, for the first time, the formation of the leptocline—a thin, 10,000-km-deep layer where the rotation rate decreases closer to the solar surface. They also produced a dataset over 100 hours long.
  - Studying the properties of this layer, accompanied by modeling of synthetic SDO observations, allows researchers to understand the role of leptocline dynamics in the emergence of solar active regions.
  - It also improves the capability to detect those active regions that are most dangerous to Earth due to their impacts on space weather.
- Results will be applied to improve the existing methodology in order to more precisely measure the dynamics of subsurface flows from SDO mission data.

** HECC provided supercomputing resources and services in support of this work.*

IMPACT: Access to HECC resources allows researchers to improve their understanding of how the Sun operates through realistic modeling and synthetic observations to test new methods for analyzing observations from NASA space missions.

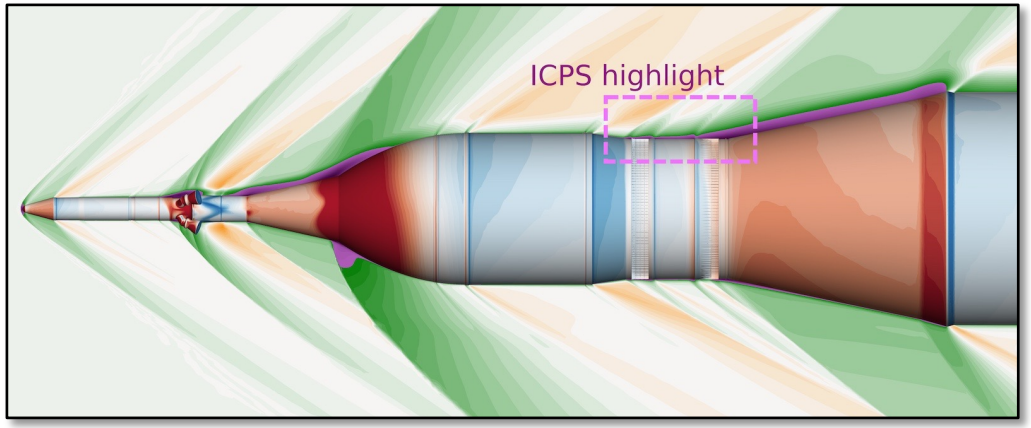
Video of a 3D power spectrum of simulated solar oscillations revealing the effect of rotational splitting of solar modes.
Irina Kitiashvili, Alan Wray, NASA/Ames; Alexander Kosovichev, *New Jersey Institute of Technology*

Flight Readiness Simulations for Artemis*

- As part of NASA's Artemis program, Ames Research Center's Space Launch System (SLS) Computational Fluid Dynamics (CFD) team is using high-performance computing resources to analyze and certify the aerodynamics of the various SLS configurations, including the recent Artemis I and the future Block 1B and Block 2 configurations.
- The SLS CFD team has been part of the development process of Artemis I through III since the beginning, supporting initial conceptual design, critical design reviews, certification, and pre-flight readiness analysis using agency-developed tools and supercomputers. These simulations allow researchers to troubleshoot and analyze features of the SLS that might not otherwise be solvable prior to flight testing.
- The flight readiness analysis from the SLS CFD team helped the SLS Loads team verify that the Artemis I vehicle will be able to withstand the aerodynamic loads it will encounter during launch. Additionally, the CFD team continues to develop complex aerodynamic databases for several SLS configurations.
- The team is currently working on flight readiness for Artemis II (the first launch in the program with astronauts on board), design certification for Artemis IV, and initial design work for Artemis IX.

** HECC provided supercomputing resources and services in support of this work.*

IMPACT: Computational fluid dynamics analysis and certification of the Space Launch System with HECC resources has enabled the SLS program to troubleshoot and analyze many elements that would previously have gone unanswered or required testing of specific hardware.



The Block 1 SLS configuration, which will be used for the Artemis I mission, uses a modified, commercially available upper stage called the Interim Cryogenic Upper Stage (ICPS). The Ames SLS CFD team analyzed the extreme geometric complexity of the ICPS "orthogrid" to assure that the simplified geometry used for vehicle certification was accurate. *Guy Schauerhamer, Science & Technology Corp.; Derek Dalle, NASA/Ames*

Papers

- "**Fluid-Structure Interaction Simulations of the ASPIRE SR01 Supersonic Parachute Flight Test**," J. Boustani, F. Cadieux, G. Kenway, M. Barad, C. Kiris, C. Brehm, Aerospace Science and Technology, vol. 126, April 29, 2022. * *https://www.sciencedirect.com/science/article/abs/pii/S127096382200270X*
- "**TOI-2046b, TOI-1181b and TOI-1516b, Three New Hot Jupiters from TESS: Planets Orbiting a Young Star, a Subgiant and a Normal Star**," P. Kabath, et al., arXiv:2205.01860 [astro-ph.EP], May 4, 2022. * *https://arxiv.org/abs/2205.01860*
- "**The Discovery of a Planetary Companion Interior to Hot Jupiter WASP-132b**," B. Hord, et al., arXiv:2205.02501 [astro-ph.EP], arXiv:2205.02501 [astro-ph.EP], May 5, 2022. * *https://arxiv.org/abs/2205.02501*
- "**A Novel Solution for Resonant Scattering Using Self-Consistent Boundary Conditions**," B. C. McClellan, S. Davis, P. Arras, arXiv:220505082 [astro-ph.EP], May 10, 2022. * *https://arxiv.org/abs/2205.05082*
- "**Another Shipment of Six Short-Period Giant Planets from TESS**," J. Rodriguez, et al., arXiv:2205.05709 [astro-ph.EP], May 11, 2022. * *https://arxiv.org/abs/2205.05709*

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- "**A Search for Exoplanets in Open Clusters and Young Associations based on TESS Objects of Interest**," Q. Sun, S. Wang, T. Gan, A. Mann, Research in Astronomy and Astrophysics, published online May 13, 2022. * *https://iopscience.iop.org/article/10.1088/1674-4527/ac6fb9*
- "**The TESS Grand Unified Hot Jupiter Survey. I. Ten TESS Planets**," S. Yee, et al., arXiv:2205.09728 [astro-ph.EP], May 19, 2022. * *https://arxiv.org/abs/2205.09728*
- "**Changing Spatial Distribution of Water Flow Charts Major Change in Mars' Greenhouse Effect**," E. Kite, et al., Science Advances, vol. 8, no. 21, May 25, 2022. * *https://www.science.org/doi/full/10.1126/sciadv.abo5894*

** HECC provided supercomputing resources and services in support of this work*

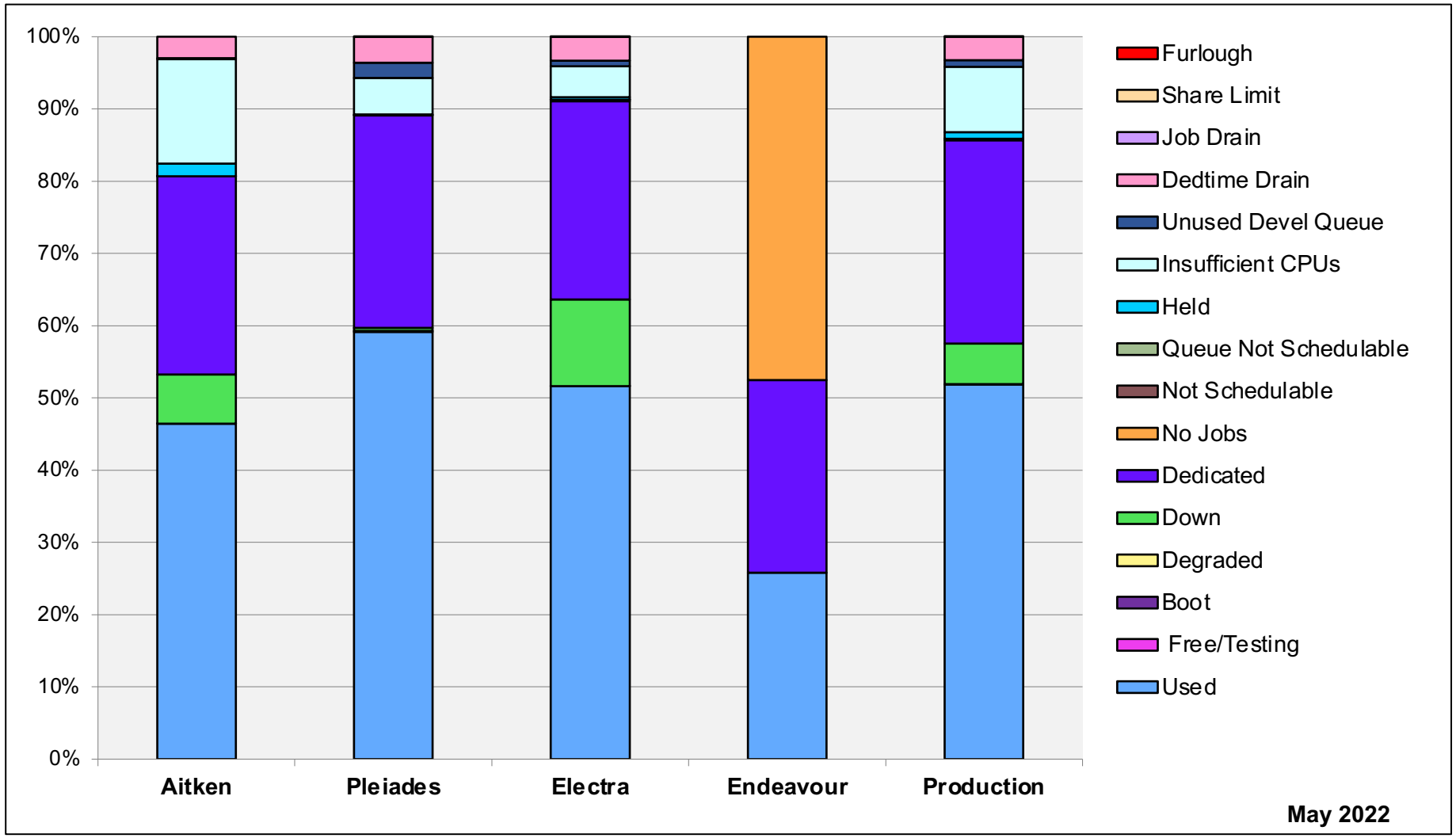
News and Events

- **New Insights into Magnetic Fields of Red Dwarfs**, *JILA*, May 17, 2022—Researchers from the University of Colorado Boulder have been looking at some of a red dwarf's unique properties, mainly their magnetic fields and convective flows, using the computing power of the Pleiades supercomputer. *https://jila.colorado.edu/news-events/articles/new-insights-magnetic-fields-red-dwarfs*
- **Simulating Supersonic Parachute Inflation for Future Mars Landings**, *NAS Feature*, May 31, 2022—The Launch Ascent and Vehicle Aerodynamics (LAVA) team in the NAS Division are developing new modeling and simulation tools and capabilities to better understand the aerodynamic processes at play during the inflation of parachutes at supersonic speeds, which the agency uses to reduce vehicle speed during atmospheric entry to Earth and Mars. *https://www.nas.nasa.gov/pubs/stories/2022/feature_LAVA_Parachutes.html*

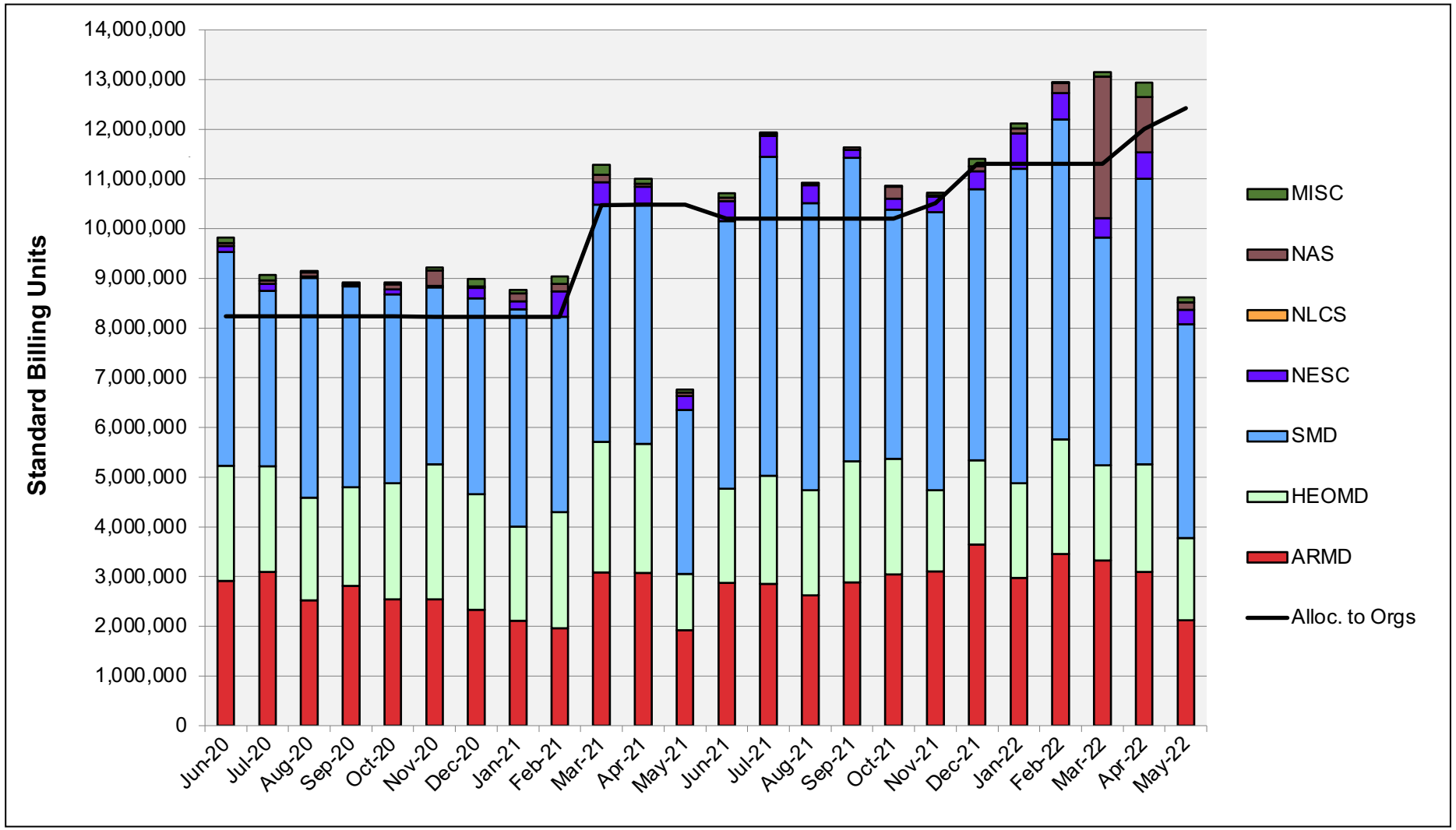
News and Events: Social Media

- **Coverage of NAS Stories**
  - Supersonic Parachute Simulations (Feature):
    - NASA Supercomputing: Twitter 9 retweets, 2 quote tweets, 47 likes; Facebook 2,665 users reached, 89 engagements, 18 likes, 4 shares.
    - NAS Division: Twitter 2 retweets, 2 quote tweets, 18 likes.

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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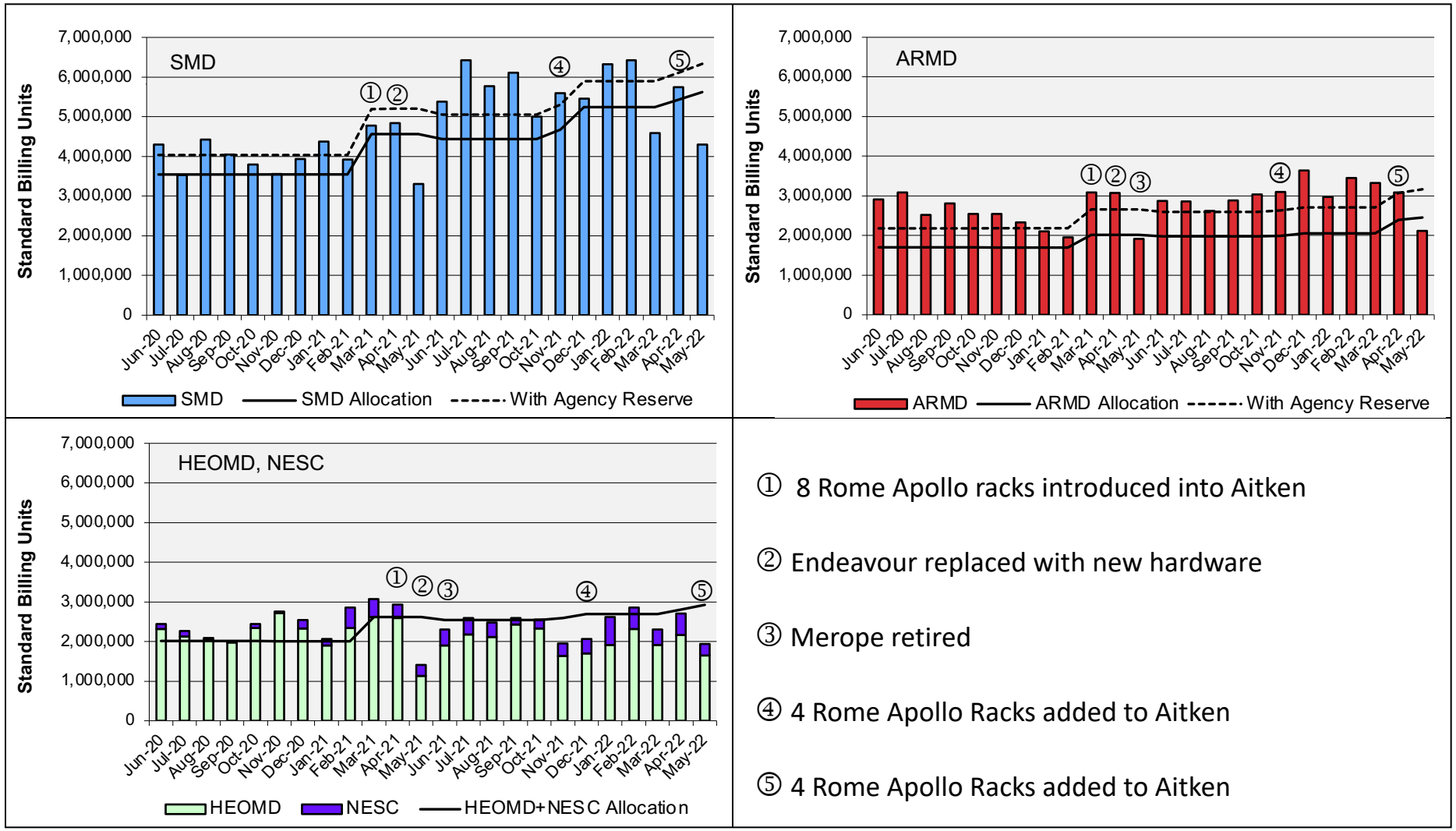


① 8 Rome Apollo racks introduced into Aitken

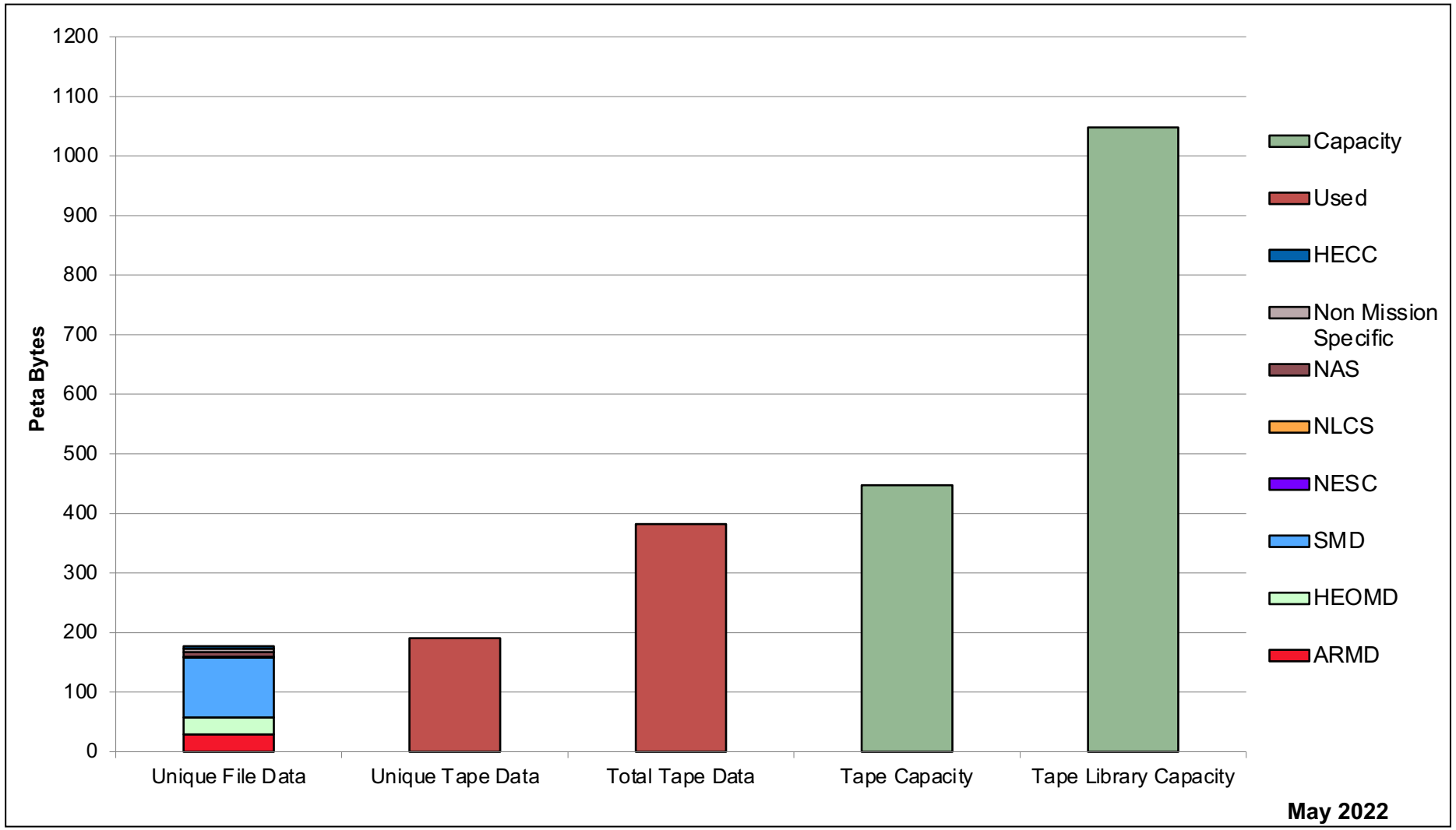
② Endeavour replaced with new hardware

③ Merope retired

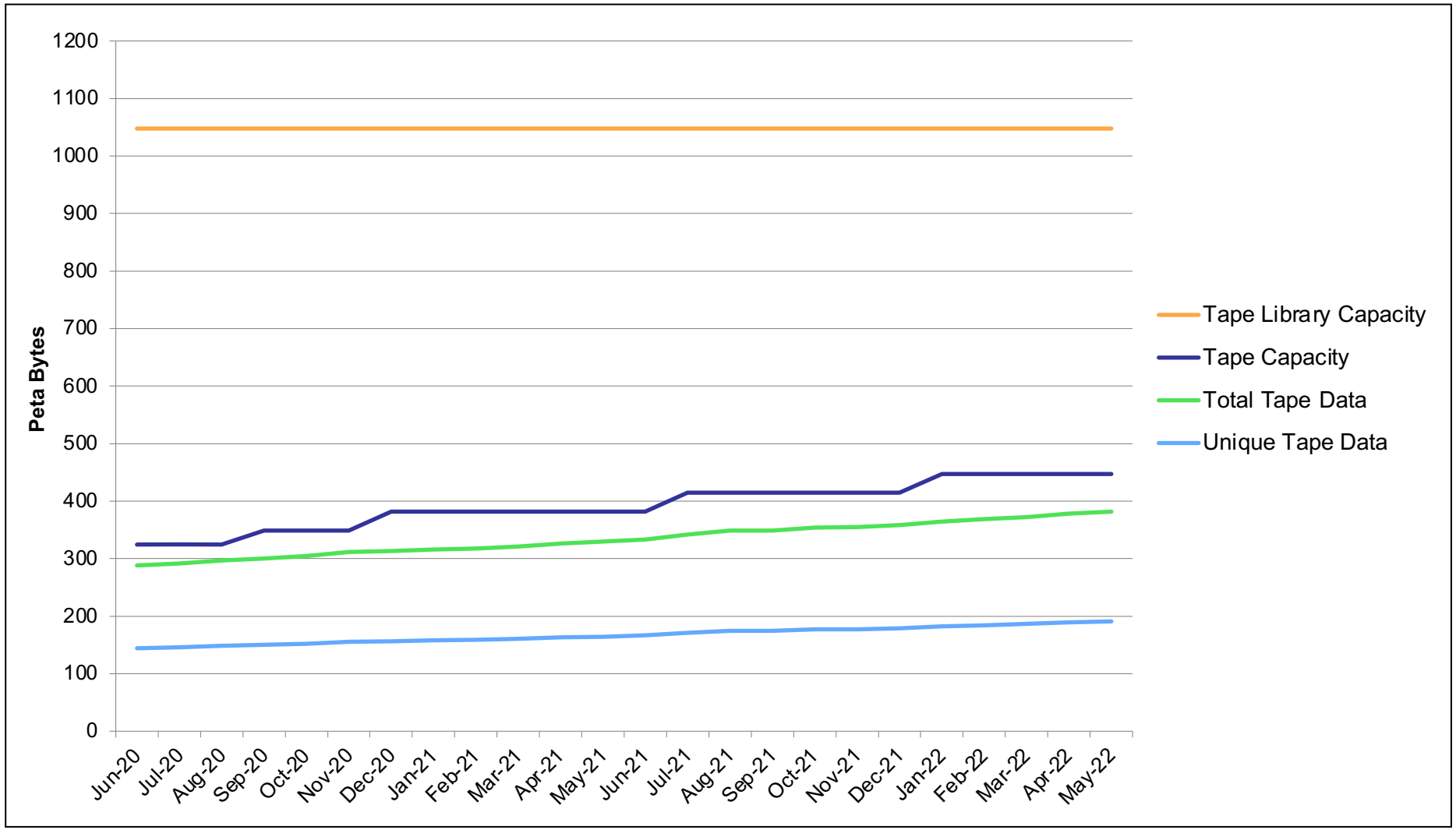
④ 4 Rome Apollo Racks added to Aitken

⑤ 4 Rome Apollo Racks added to Aitken

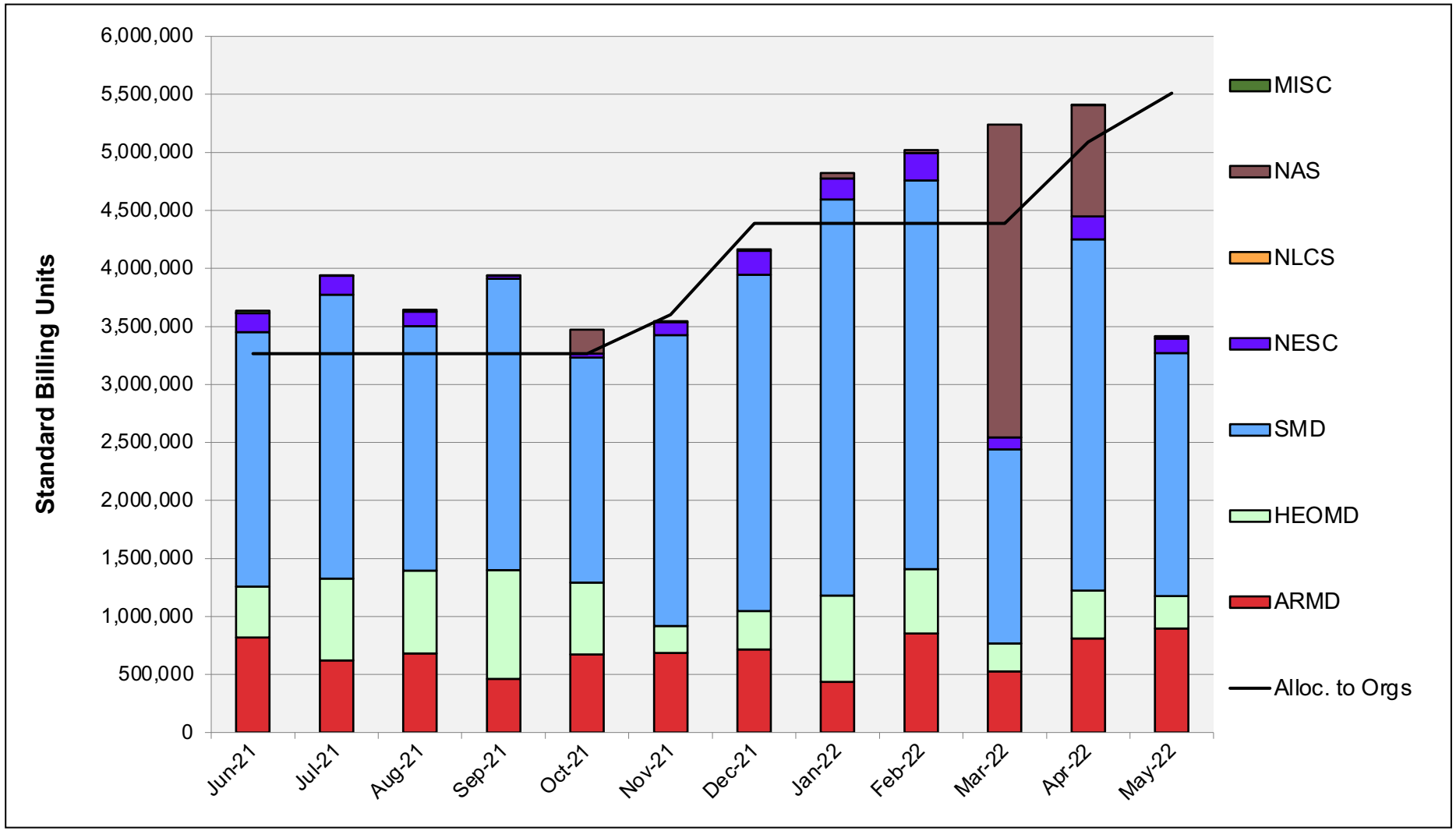
Tape Archive Status



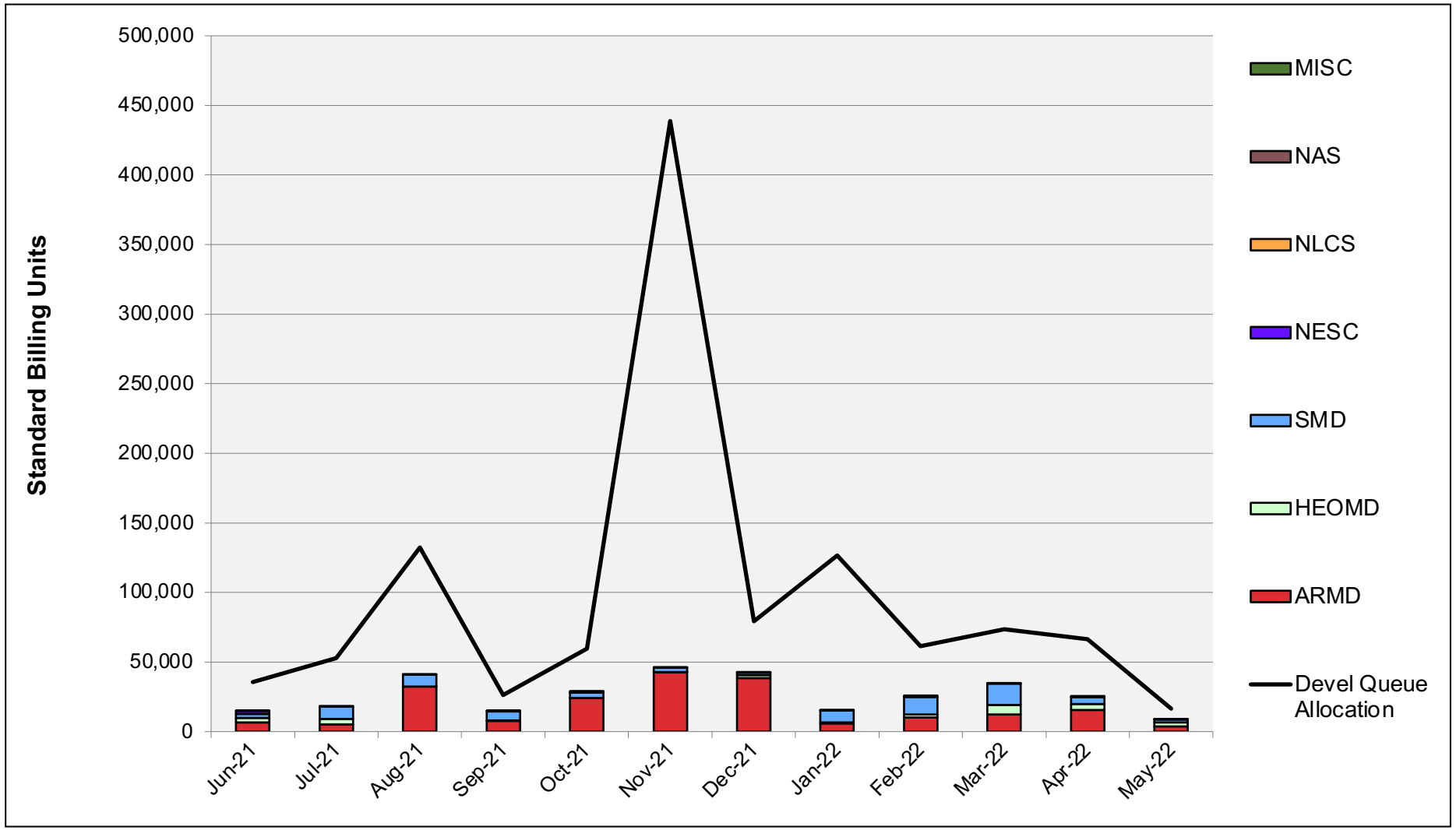
Tape Archive Status



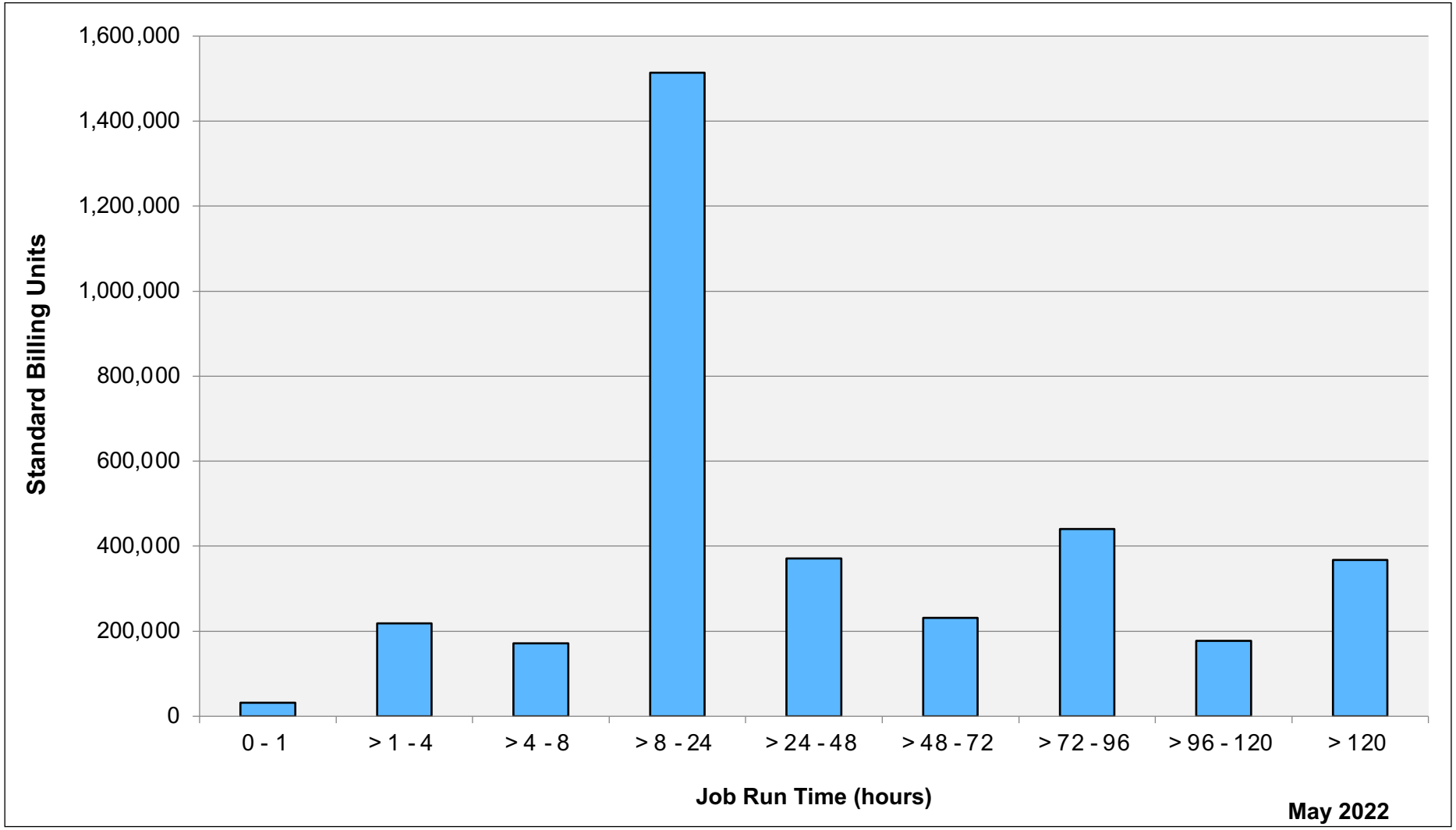
Aitken: SBUs Reported, Normalized to 30-Day Month



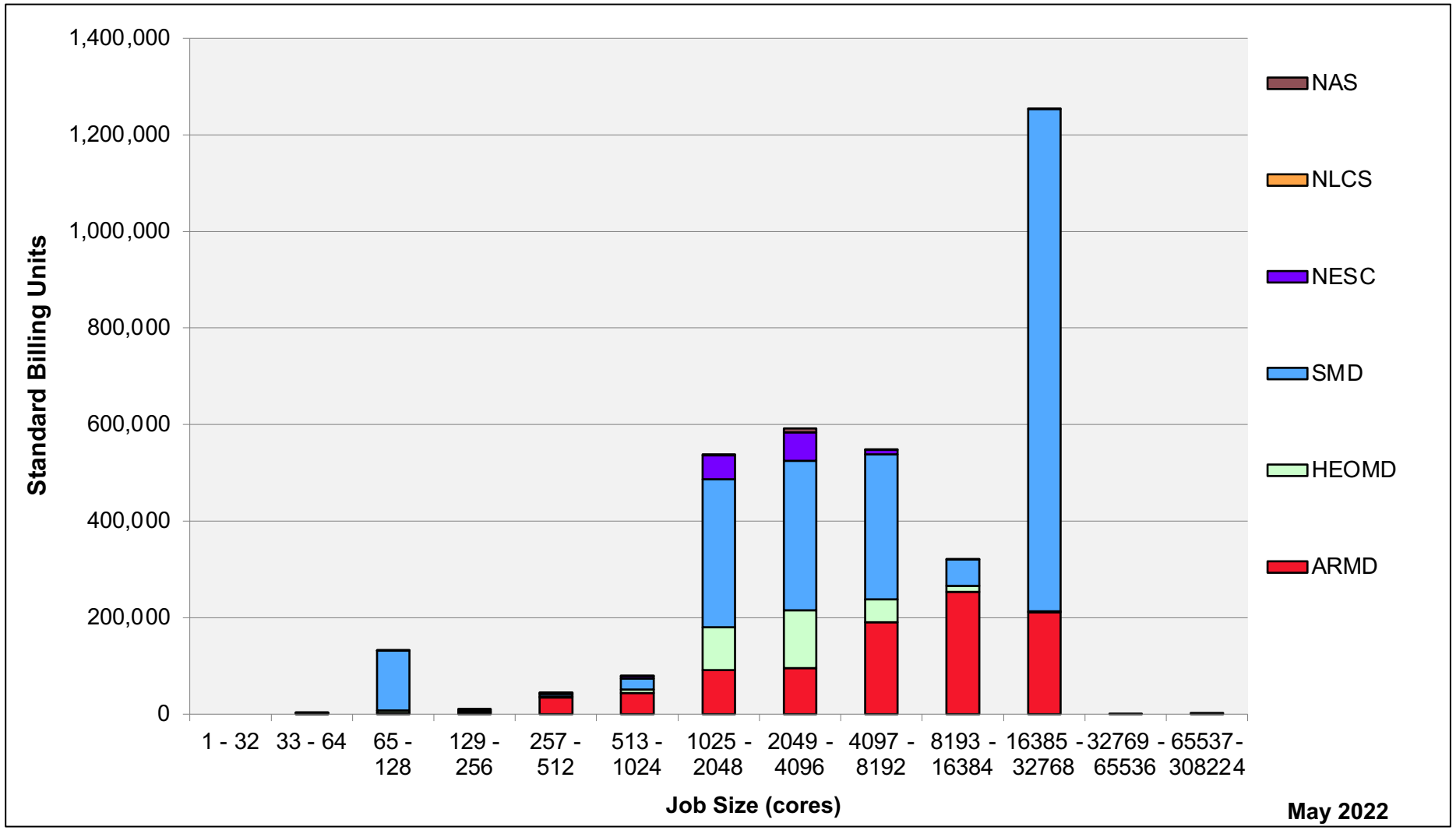
Aitken: Devel Queue Utilization



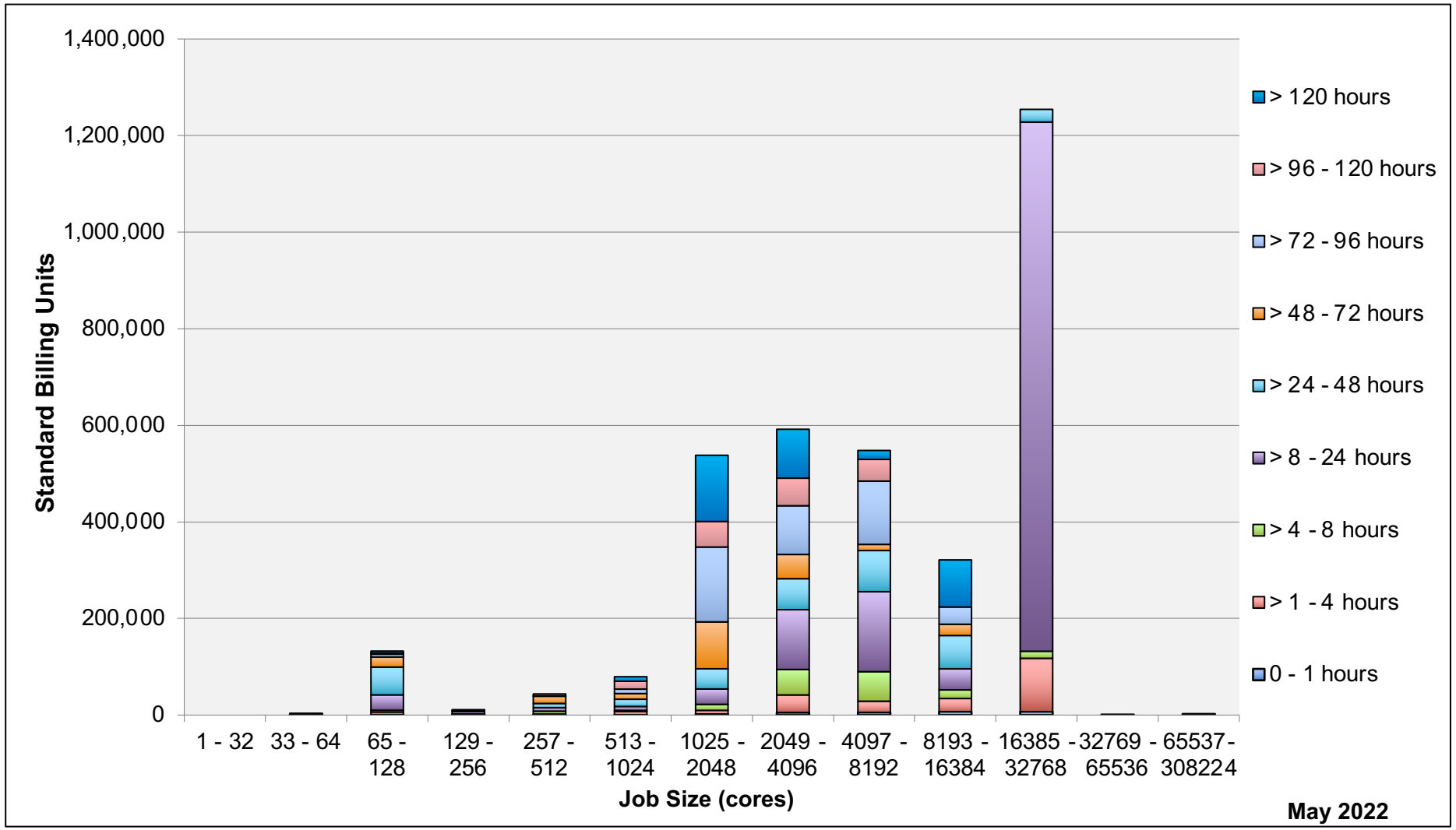
Aitken: Monthly Utilization by Job Length



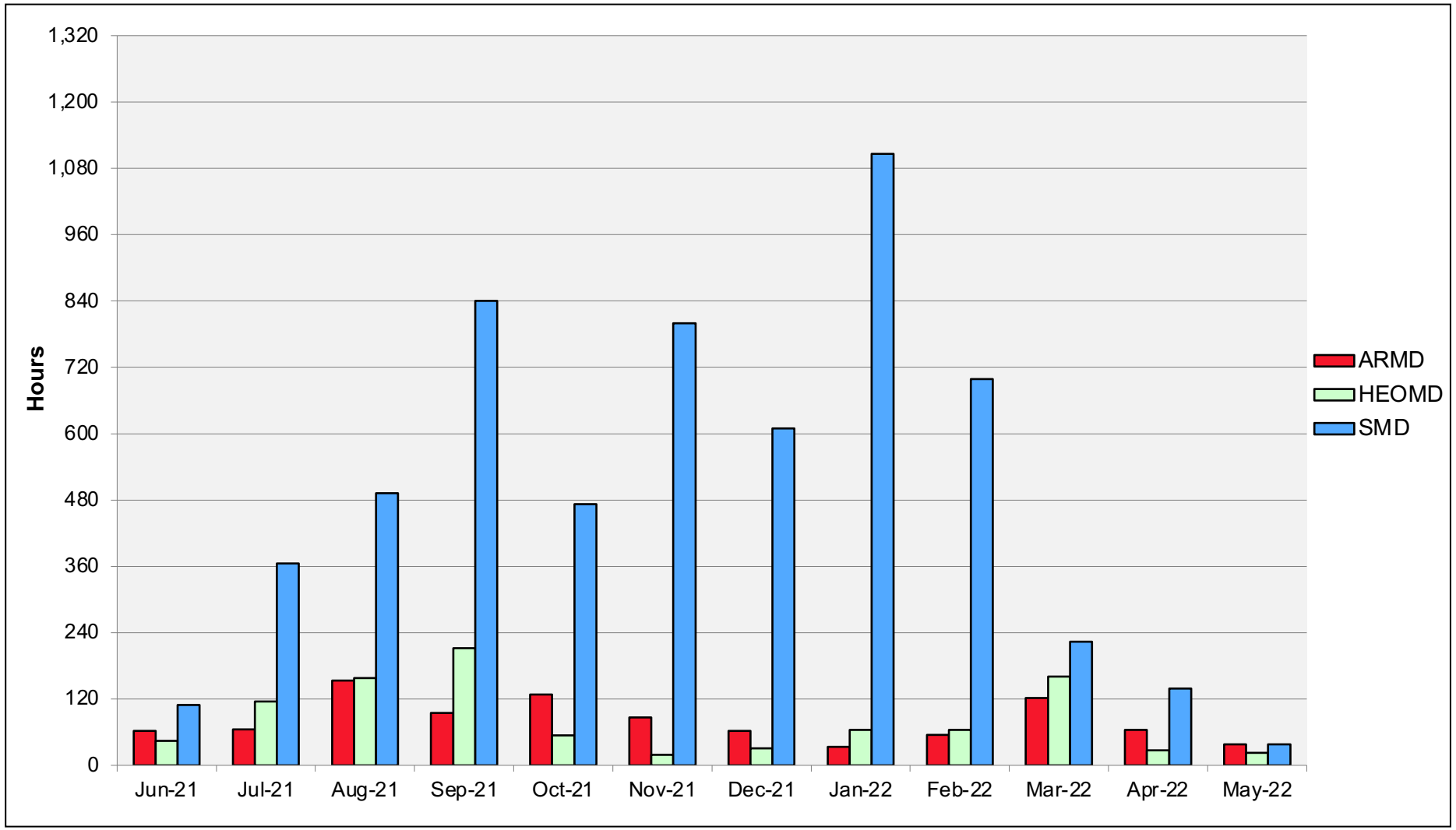
Aitken: Monthly Utilization by Job Size



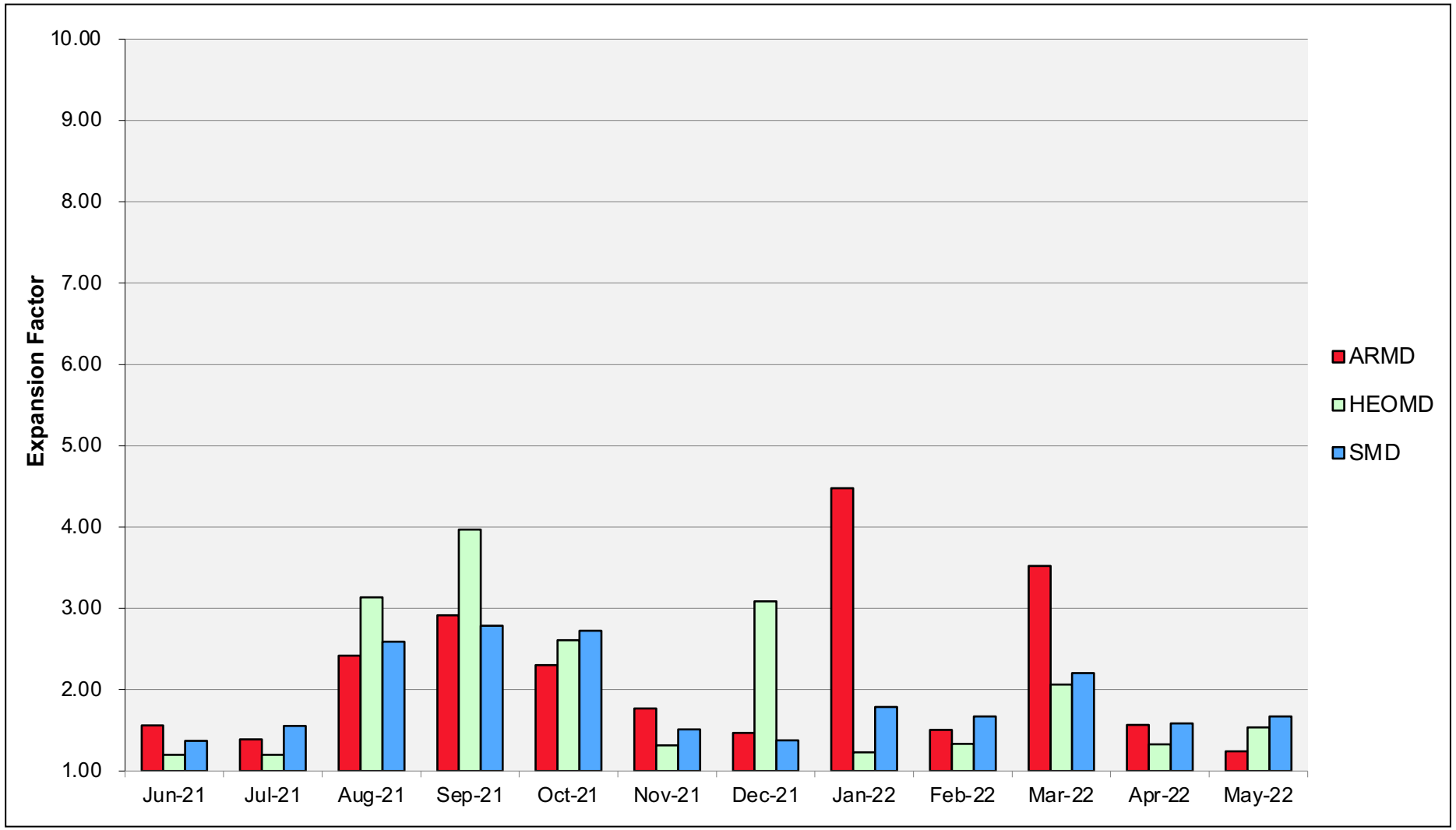
Aitken: Monthly Utilization by Size and Length



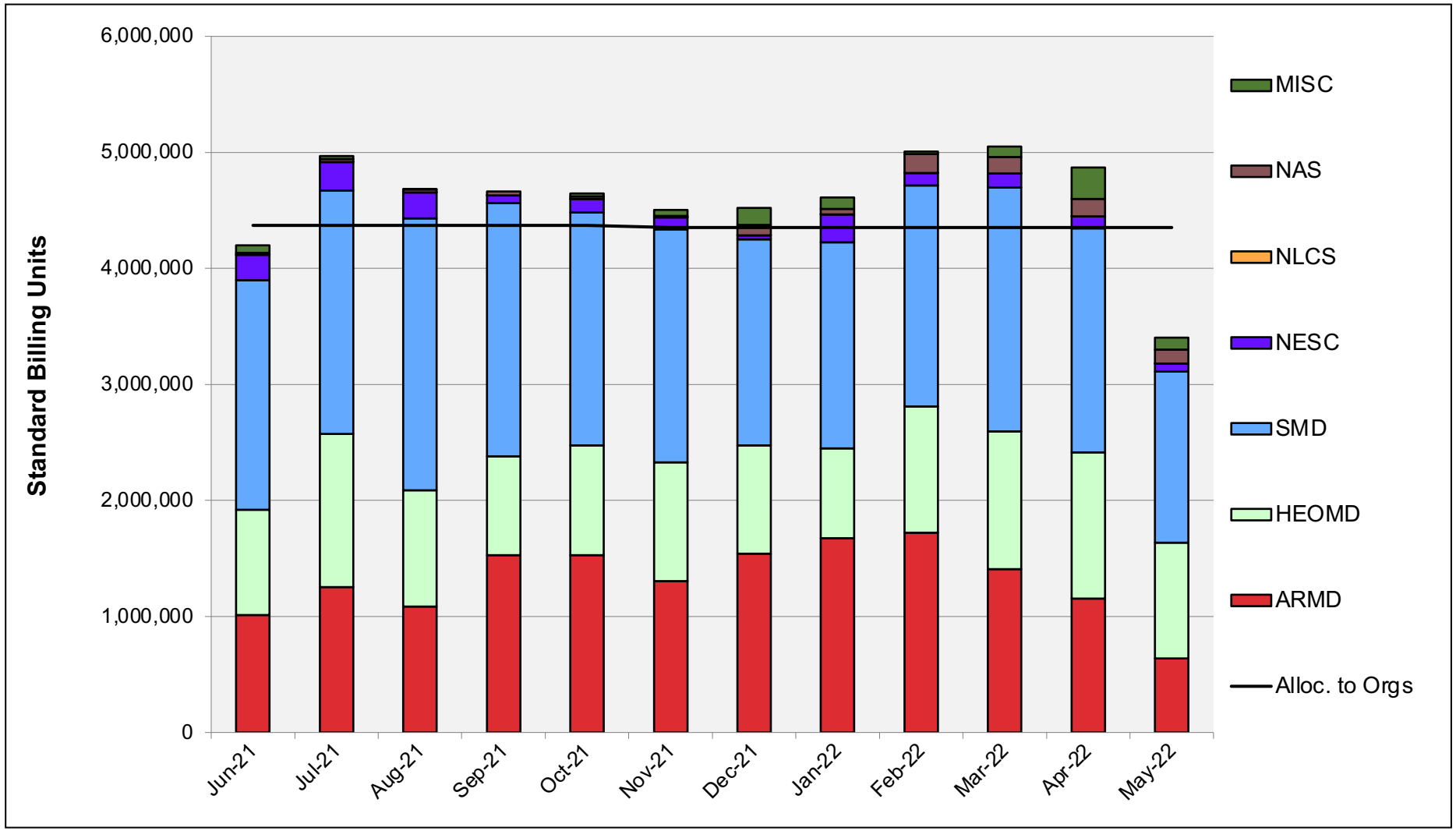
Aitken: Average Time to Clear All Jobs



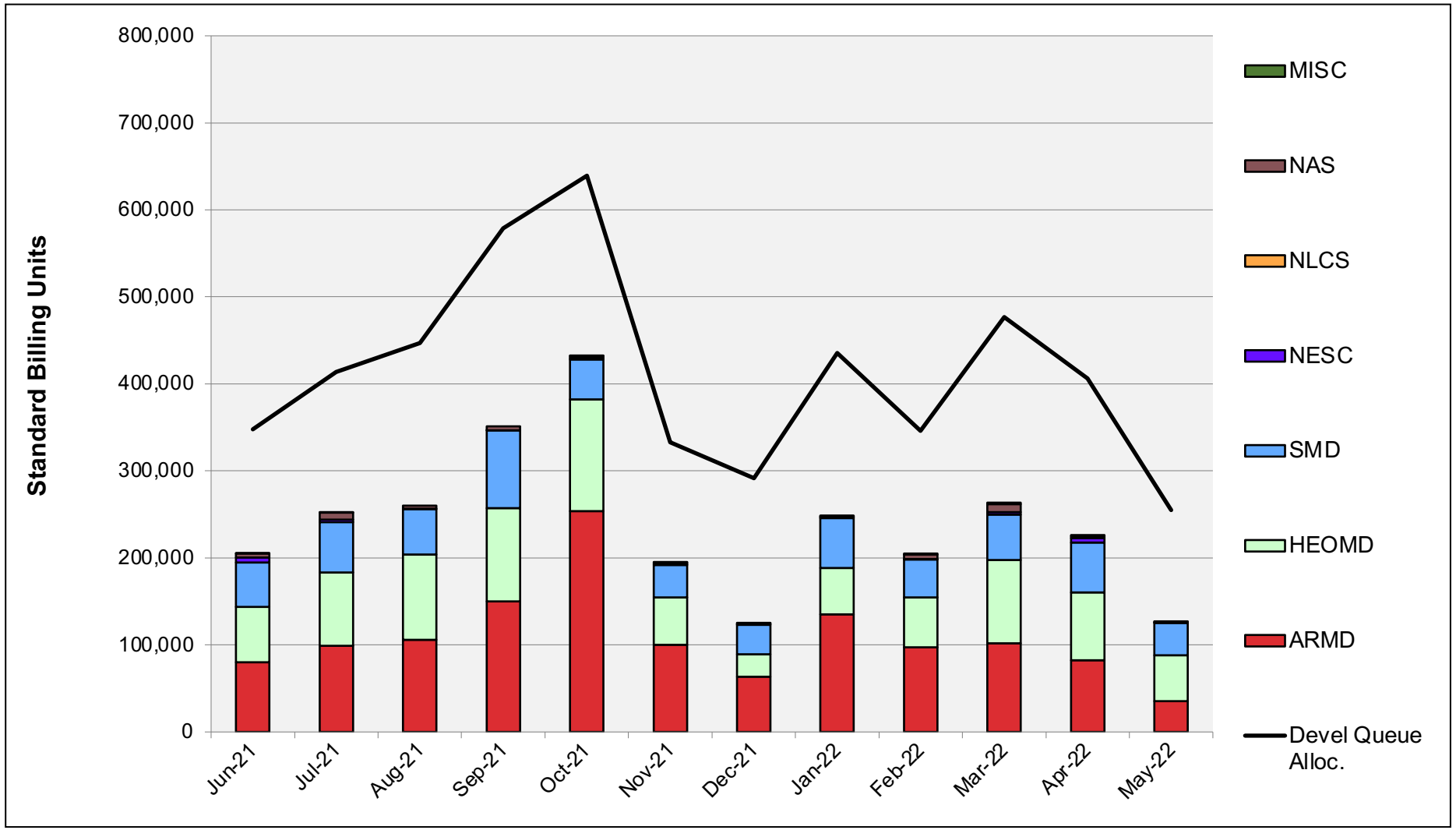
Aitken: Average Expansion Factor



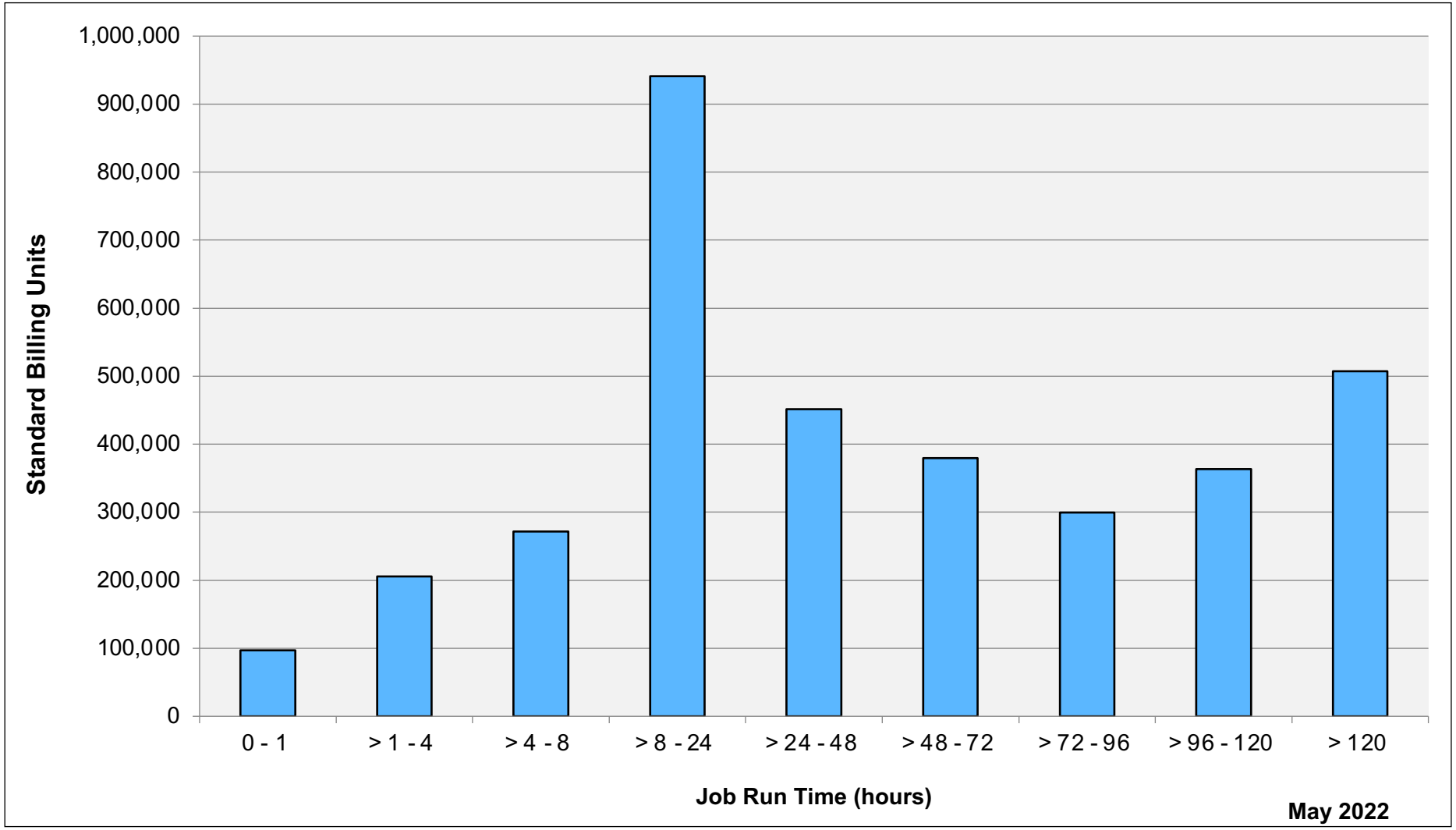
Pleiades: SBUs Reported, Normalized to 30-Day Month



Pleiades: Devel Queue Utilization



Pleiades: Monthly Utilization by Job Length



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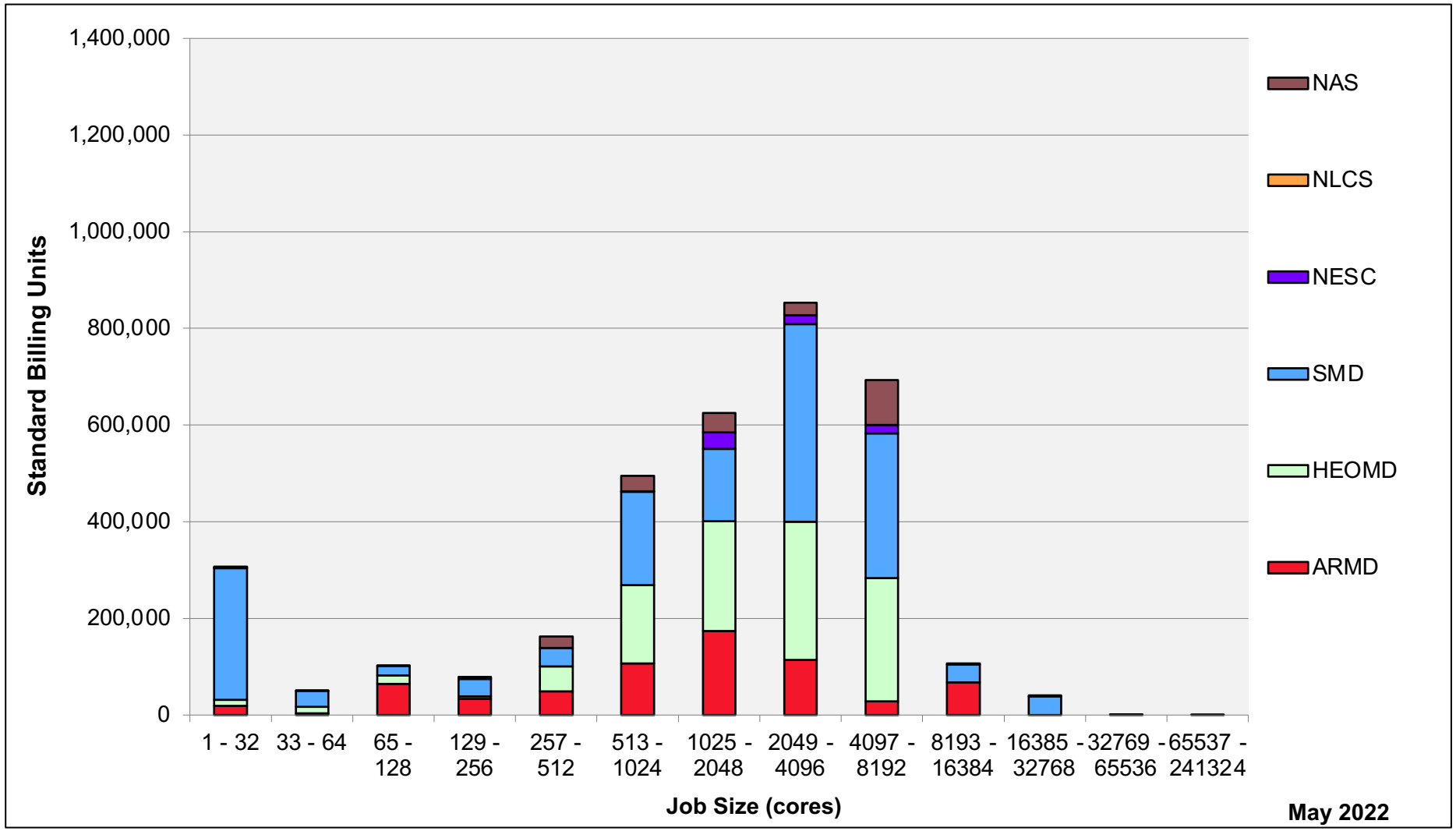
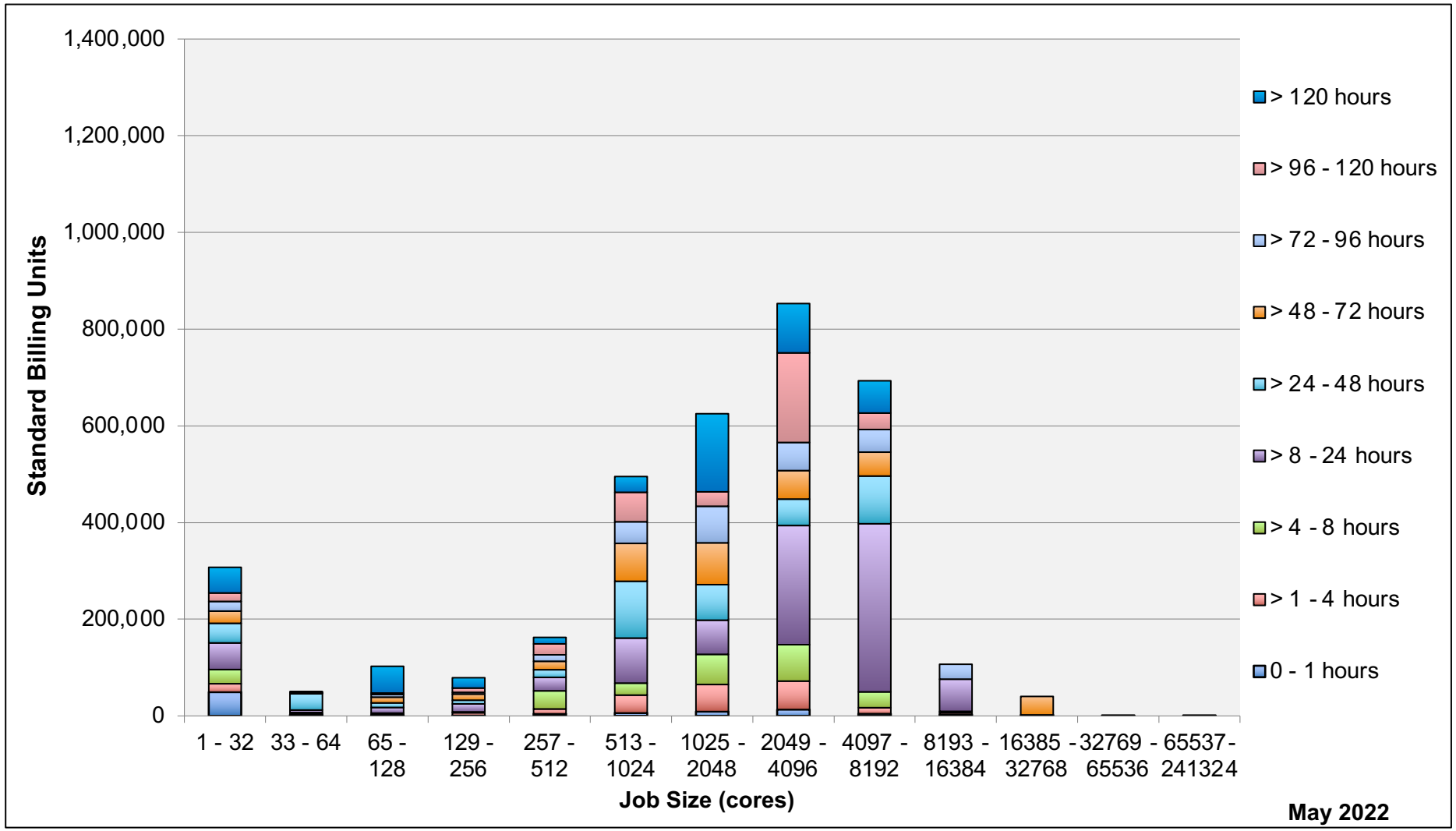
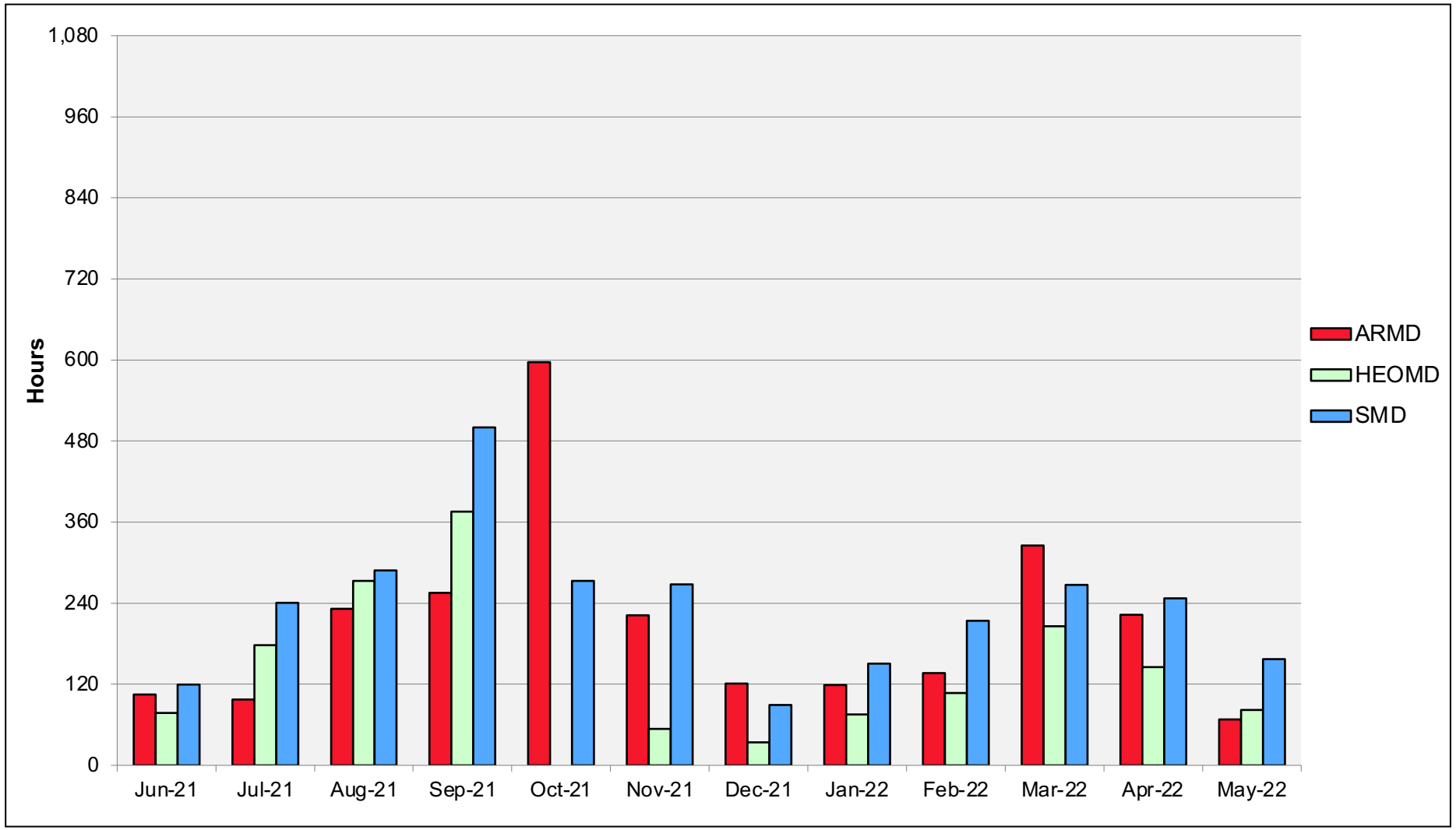


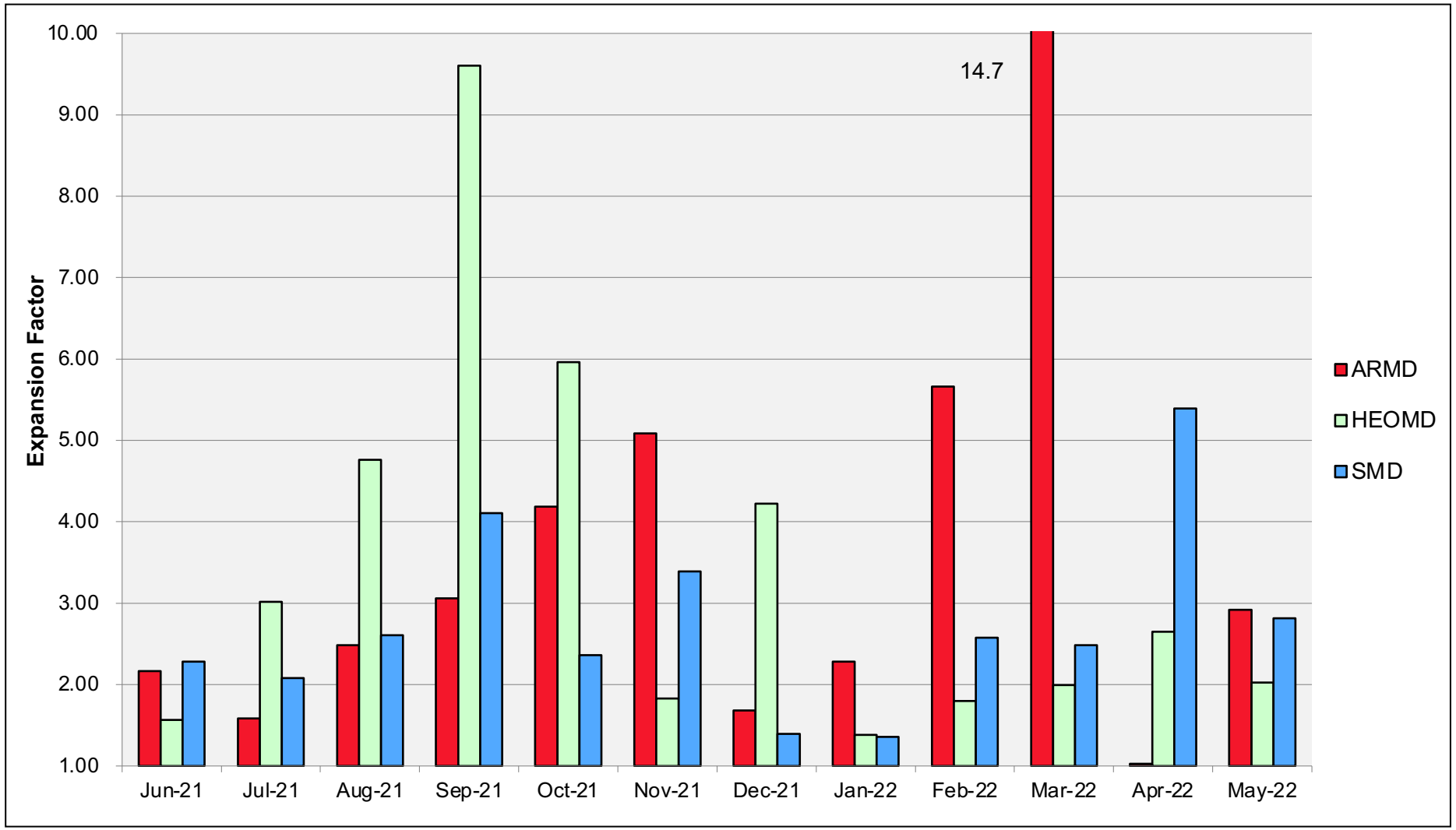
Pleiades: Monthly Utilization by Size and Length



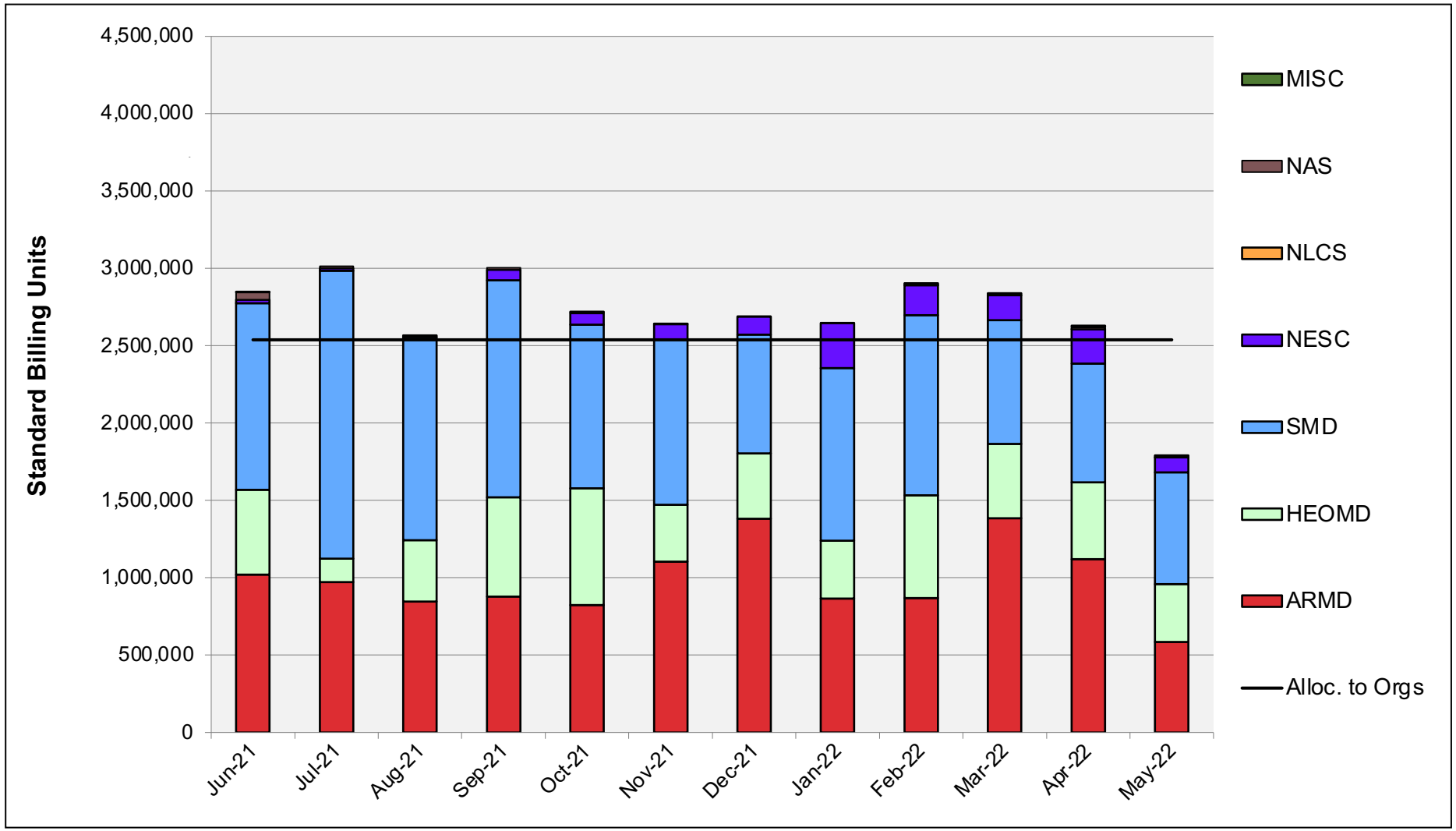
Pleiades: Average Time to Clear All Jobs



Pleiades: Average Expansion Factor



Electra: SBUs Reported, Normalized to 30-Day Month



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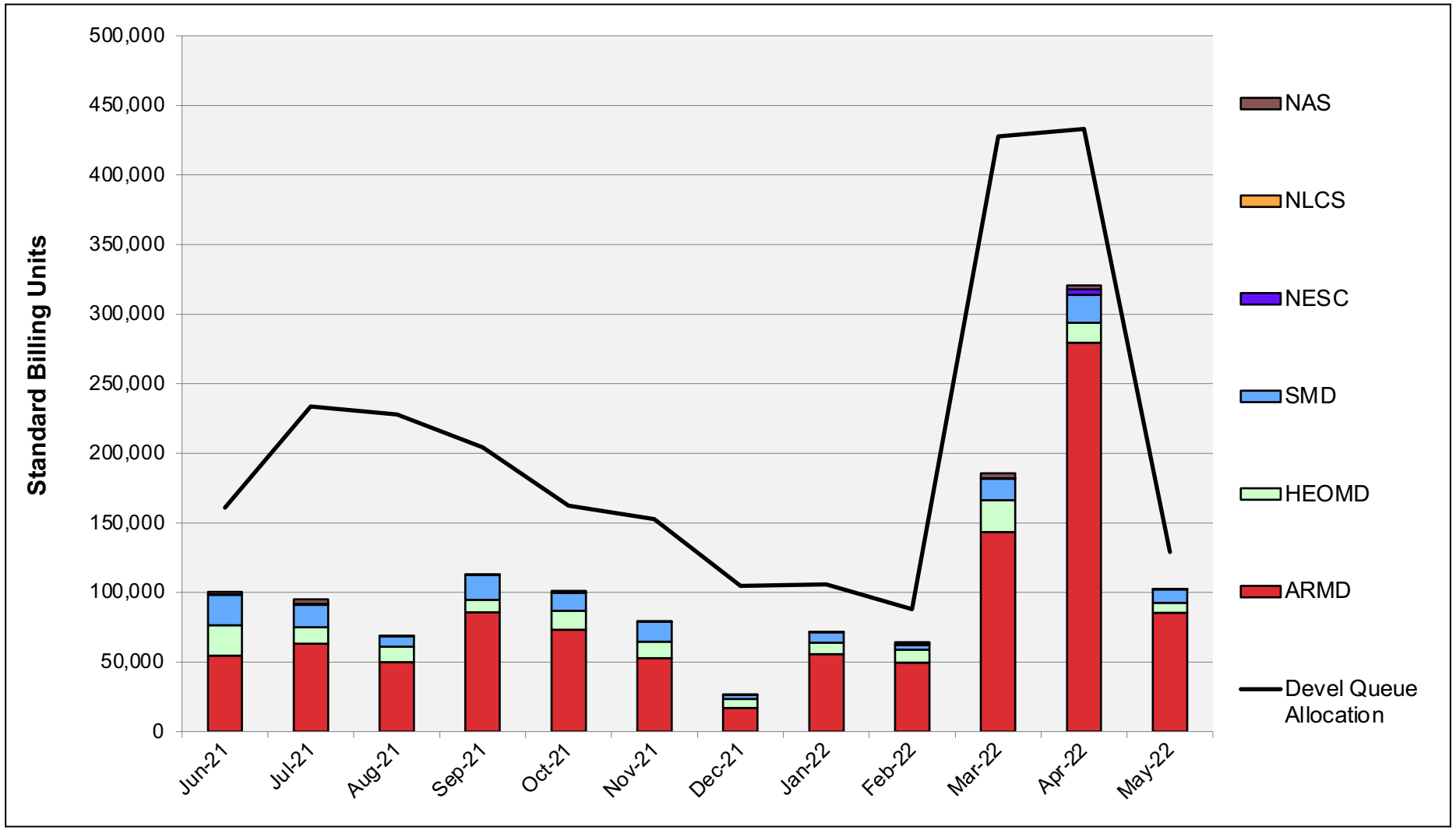
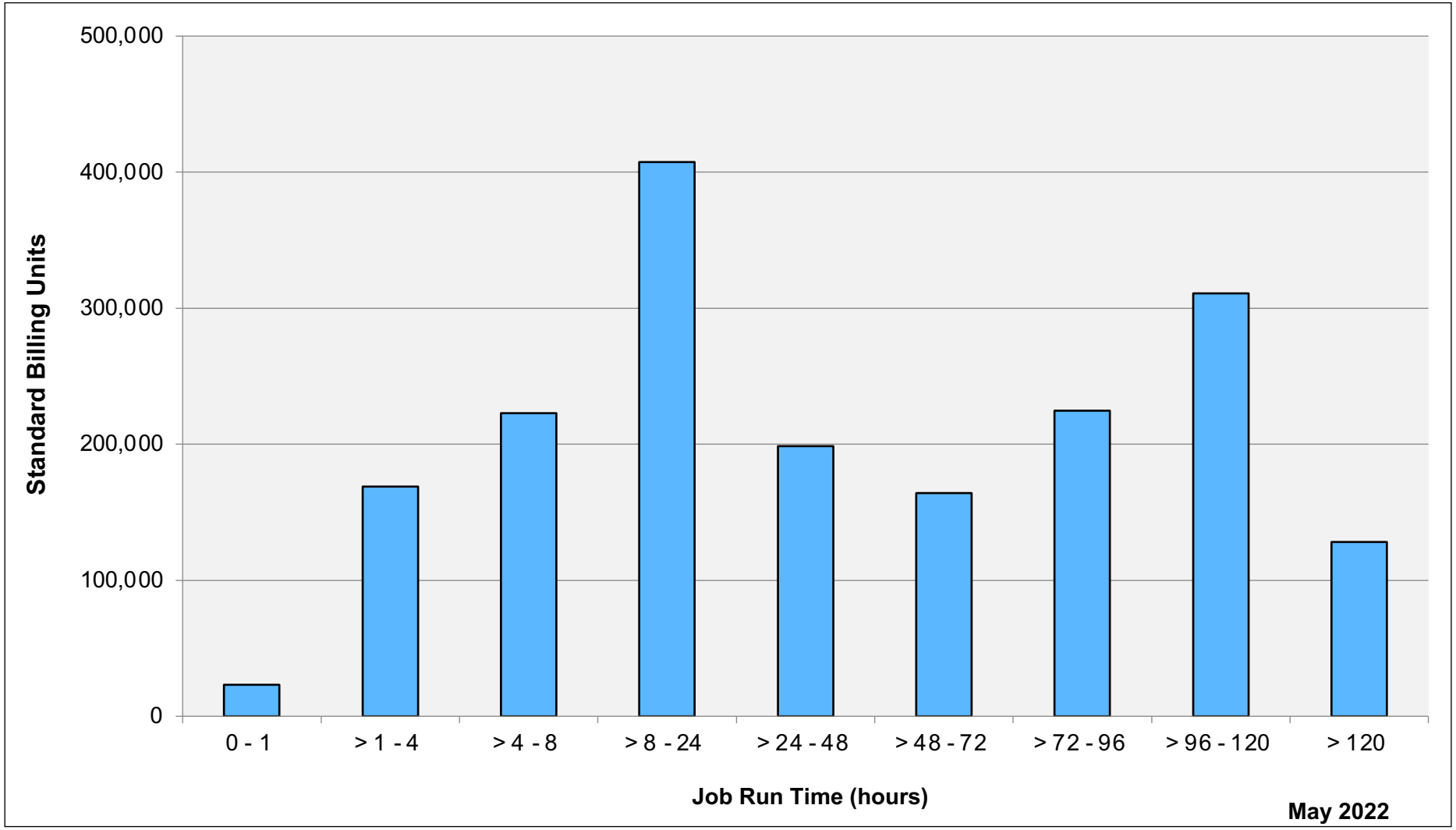
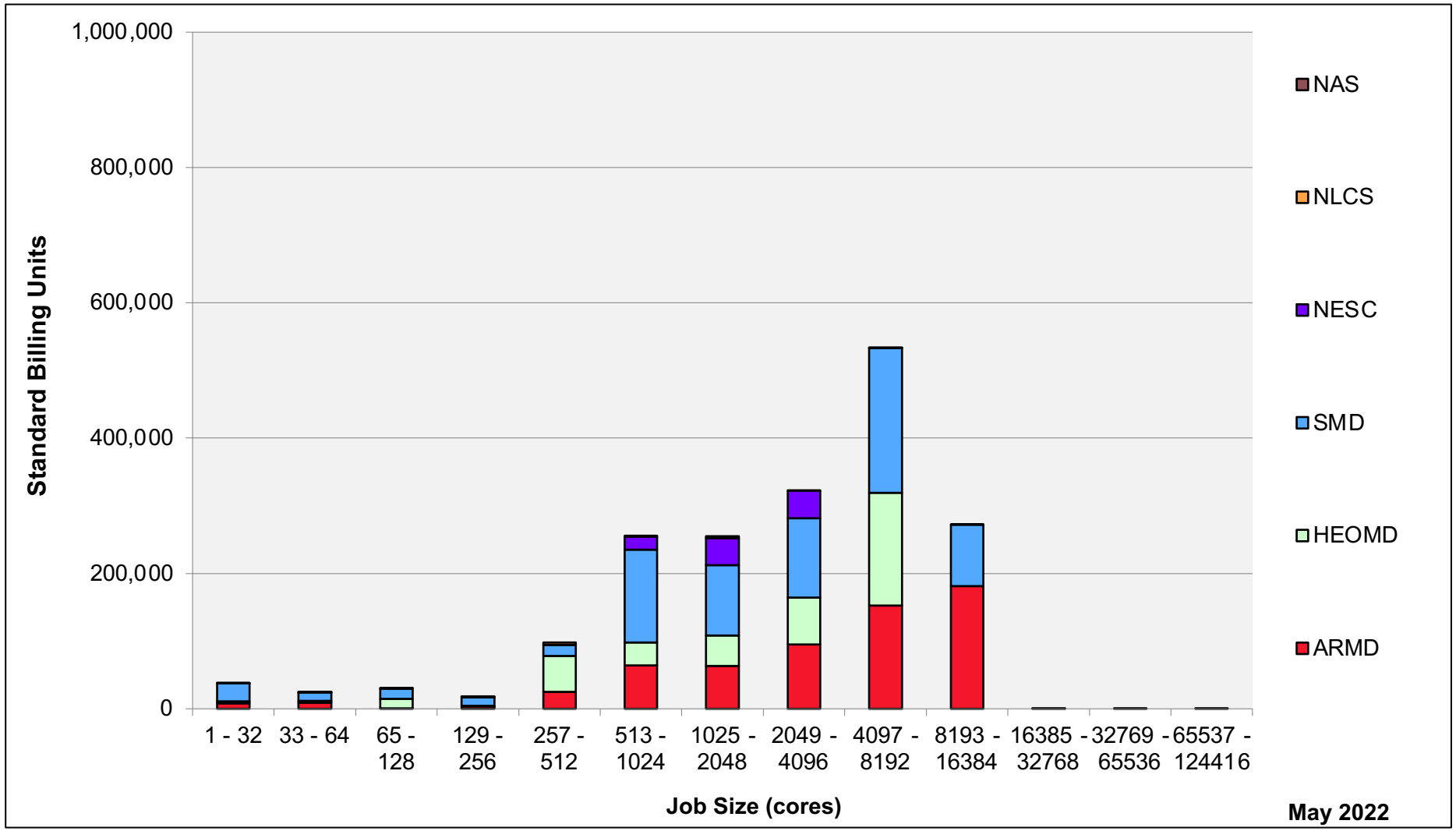


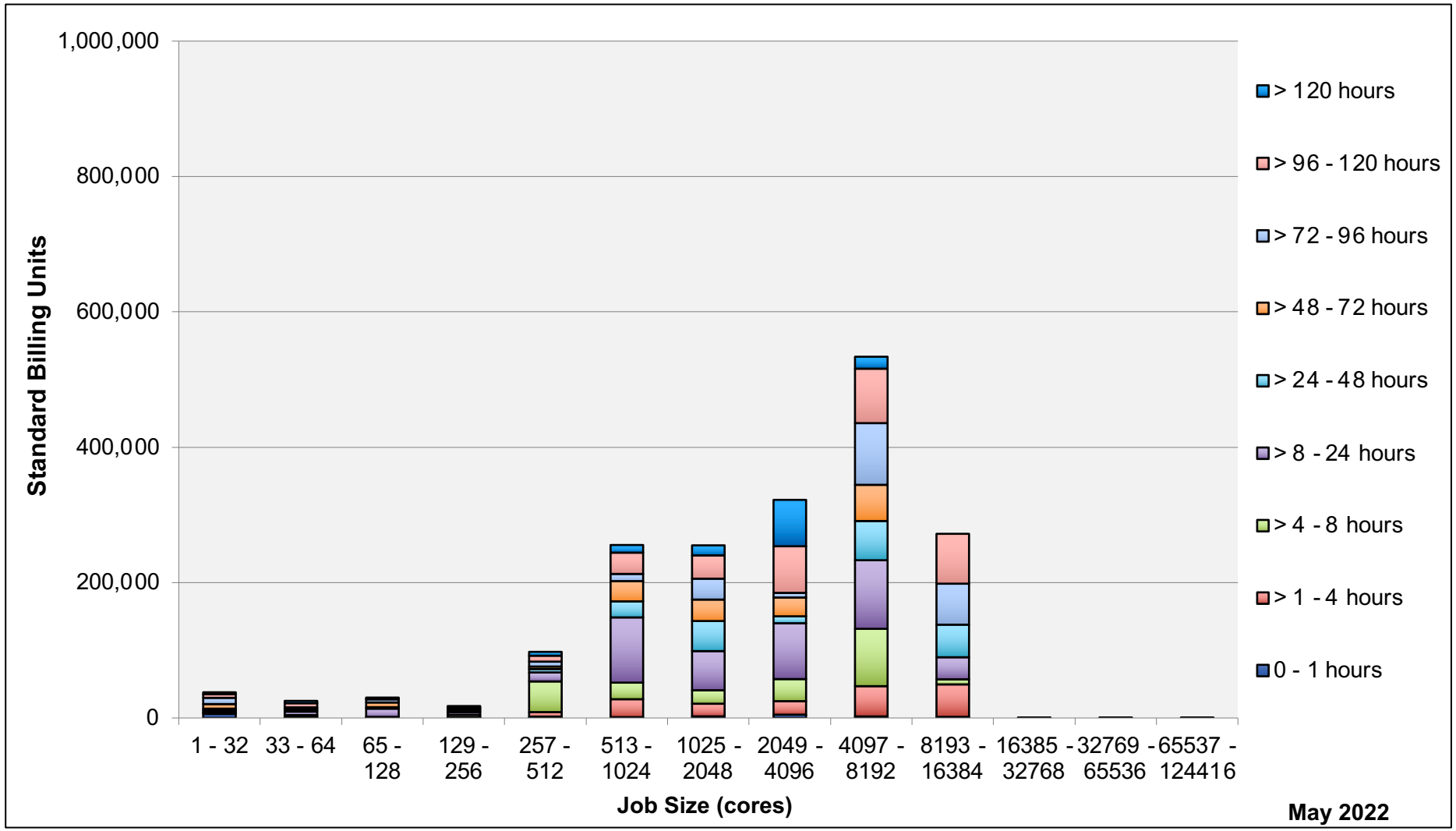
Electra: Monthly Utilization by Job Length



Electra: Monthly Utilization by Job Size



Electra: Monthly Utilization by Size and Length



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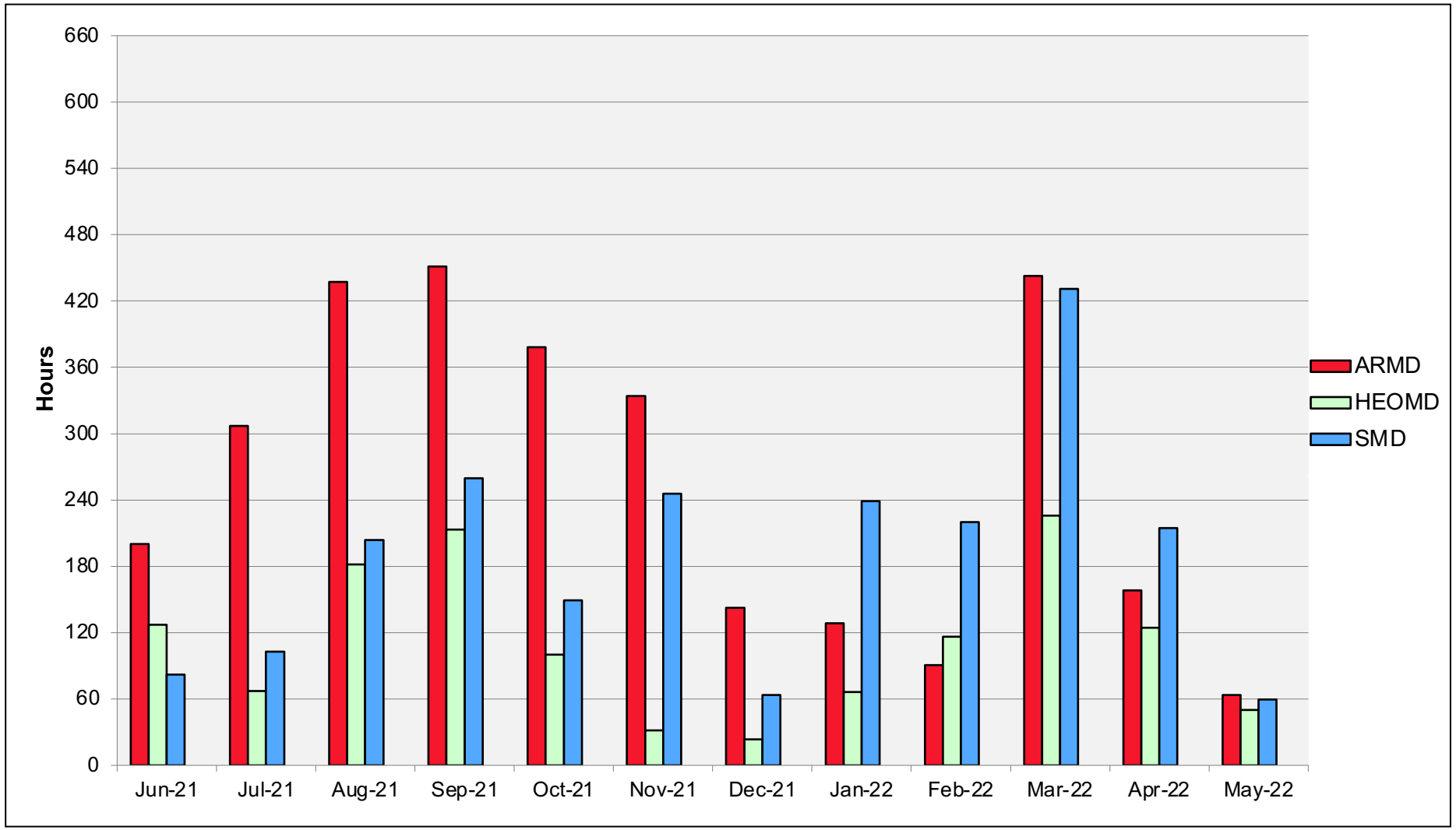

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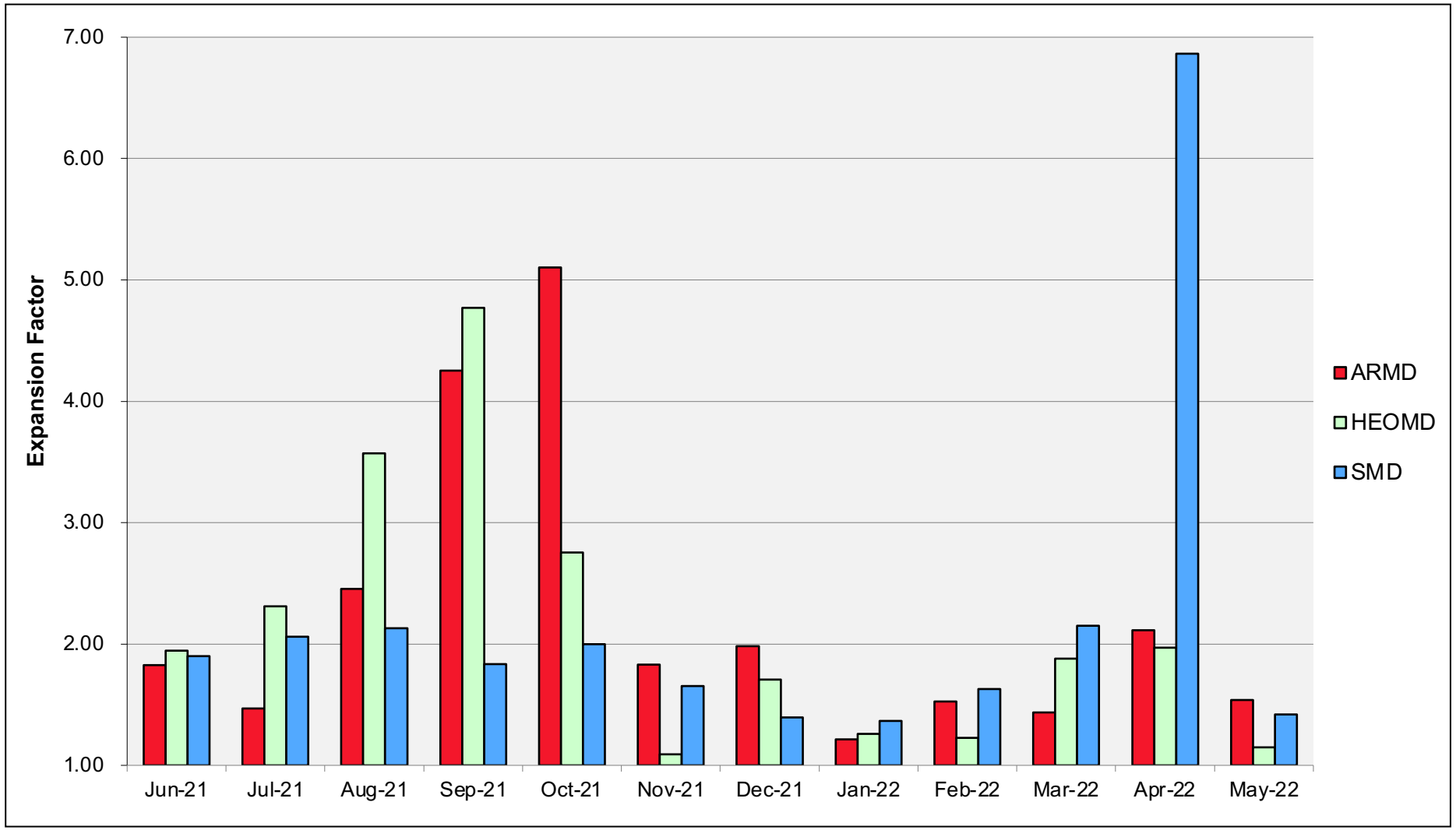
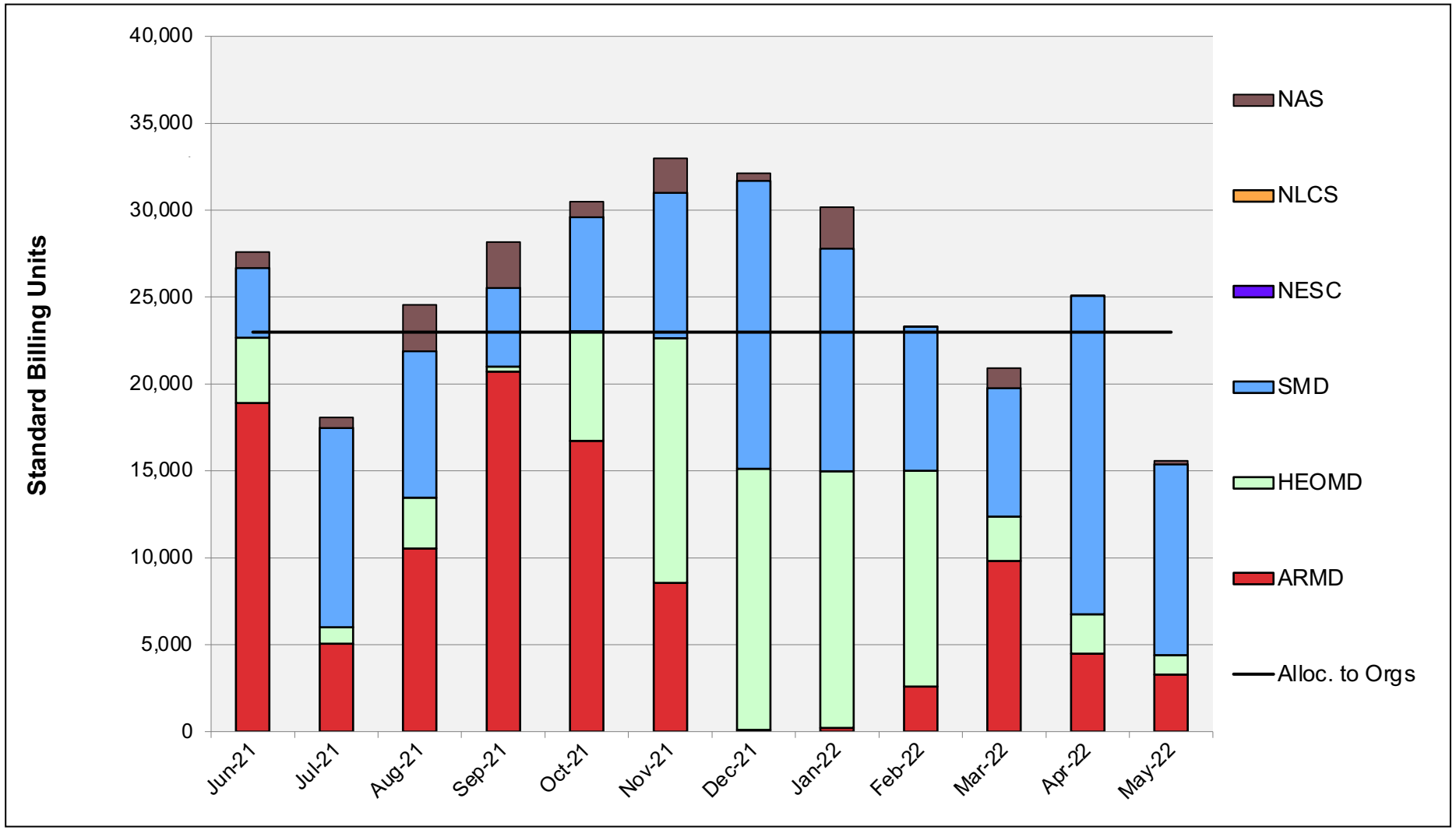
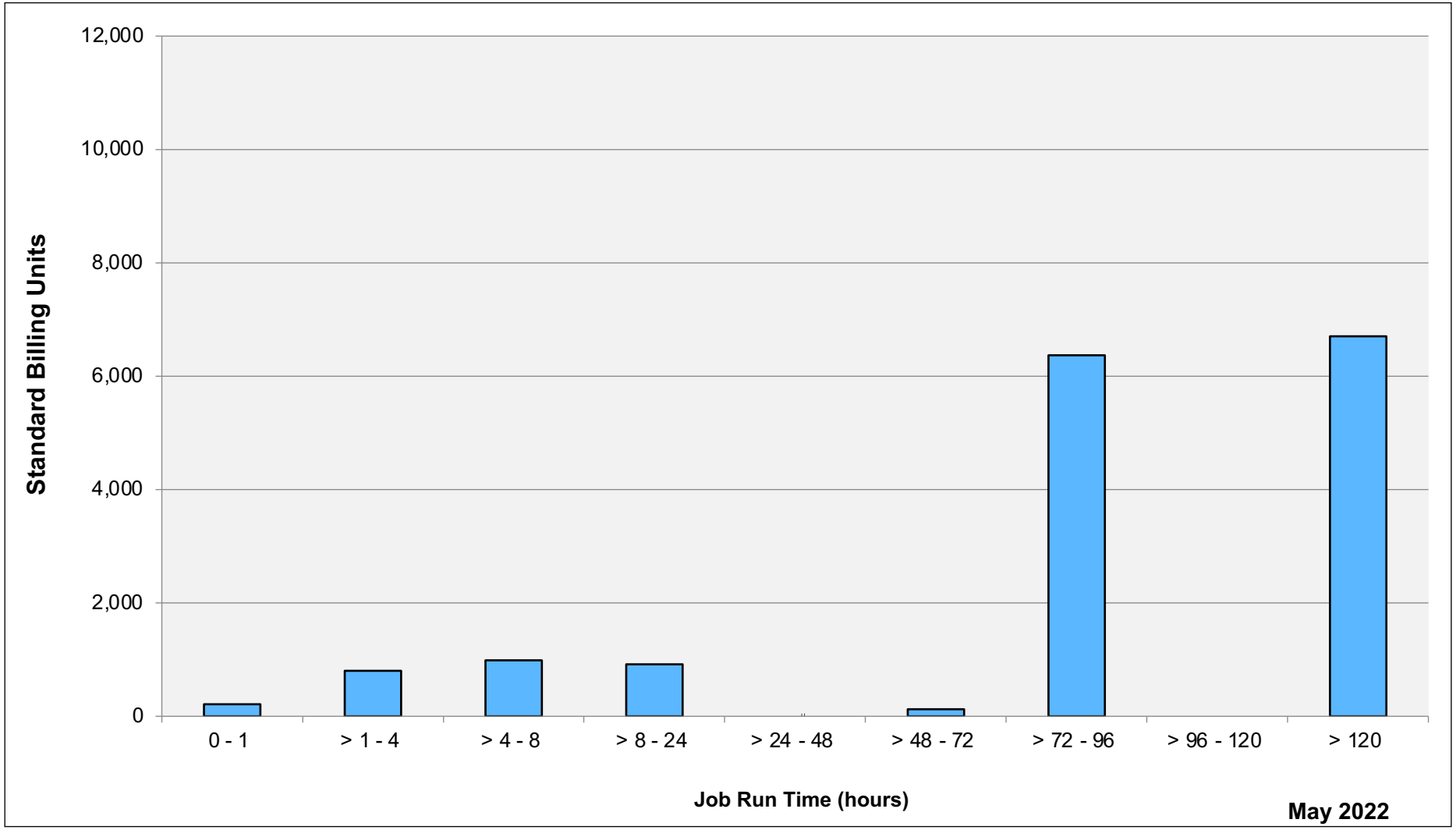


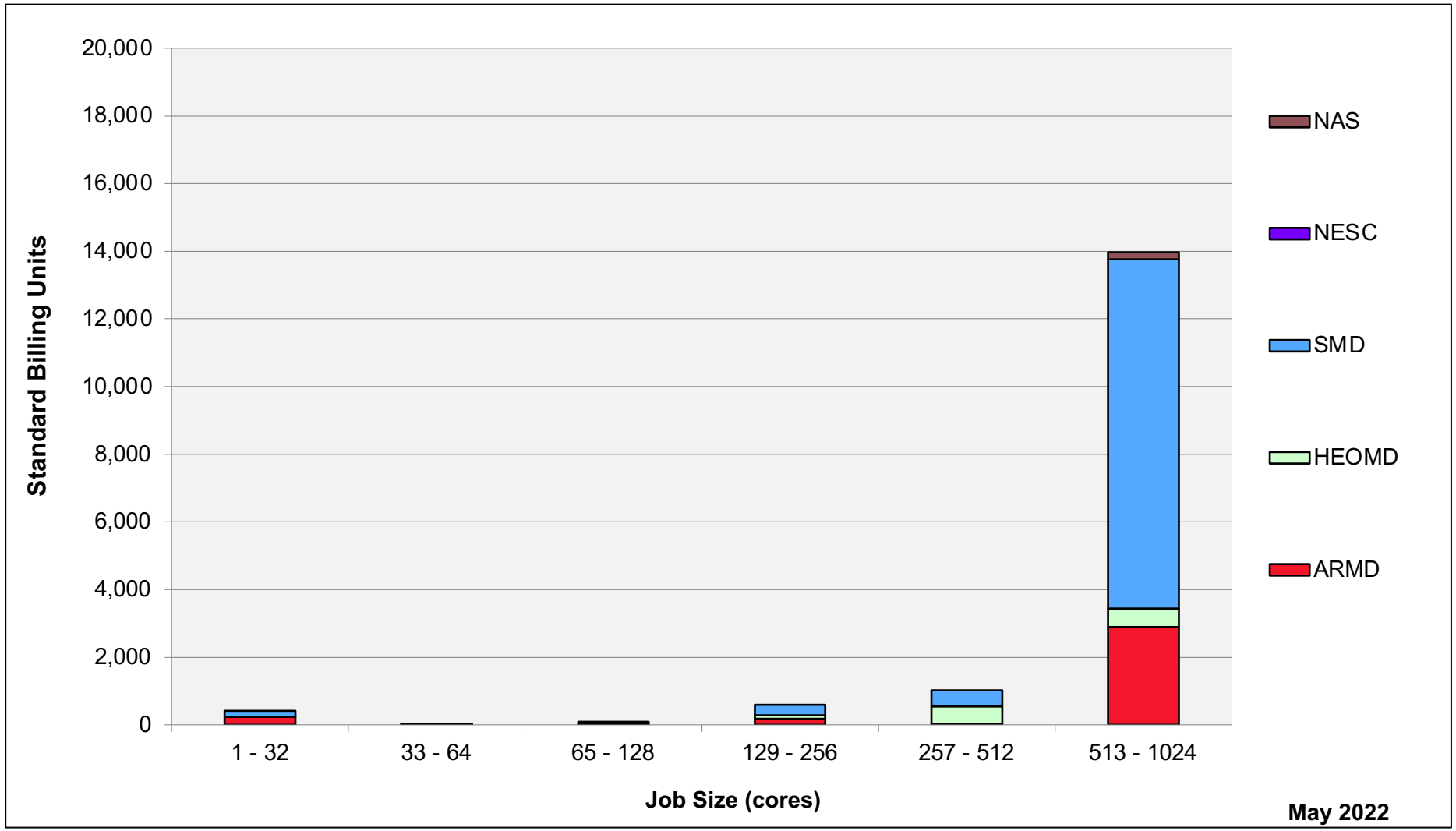
Endeavour: SBUs Reported, Normalized to 30-Day Month



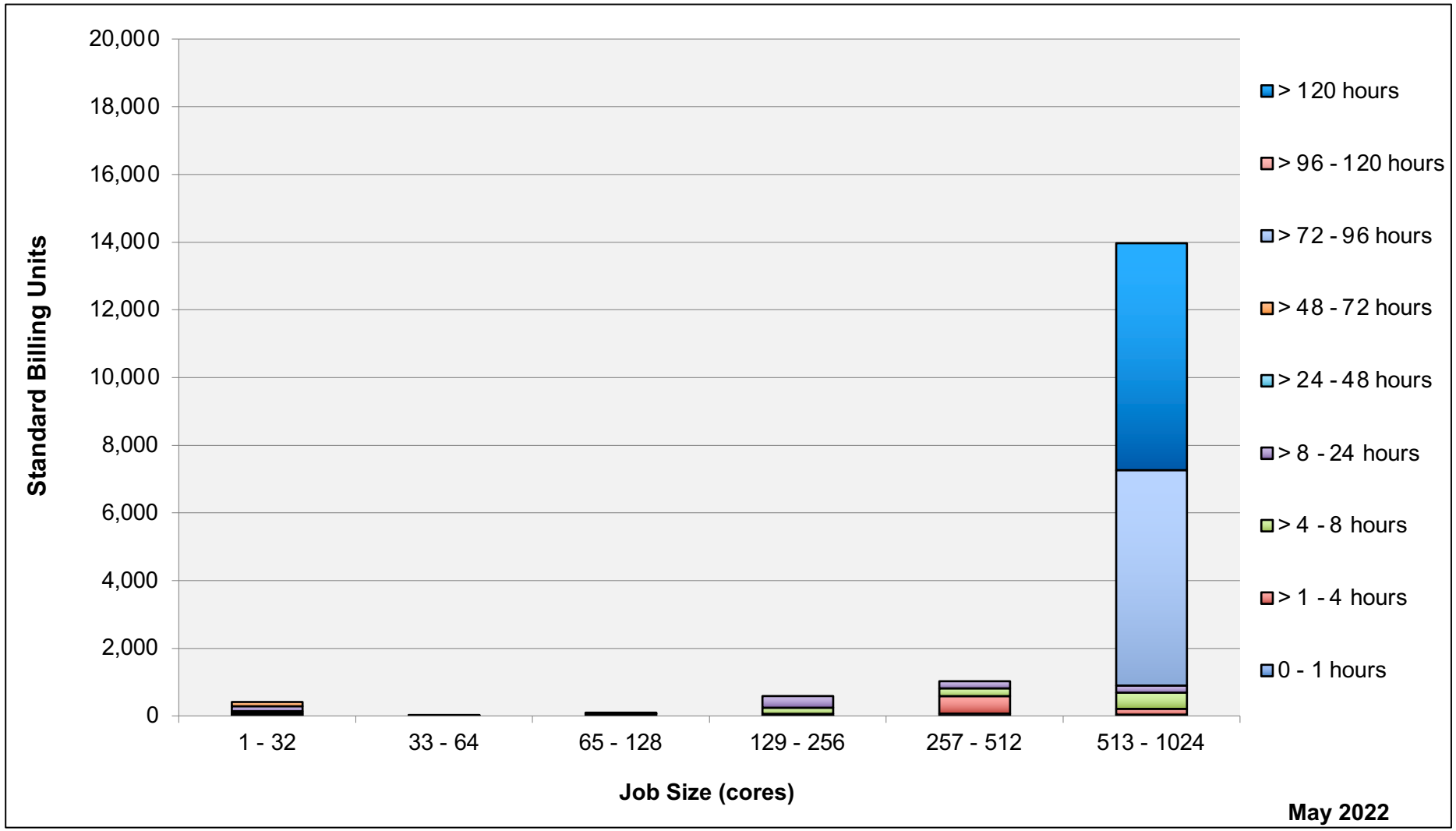
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor